

# 2005

## Swift Creek Reservoir & Watershed Hydrologic and Water Quality Data



**Addison-Evans Water Production & Laboratory Facility**  
**Department of Utilities**  
**&**  
**Department of Environmental Engineering**  
**Chesterfield, Virginia**  
**&**  
**KCI Technologies, Inc.**

# **Swift Creek Reservoir & Watershed Hydrologic and Water Quality Data**

**2005**

BY

Addison-Evans Water Production & Laboratory  
Facility

Chesterfield County Department of Utilities &  
Department of Environmental Engineering  
Chesterfield, Virginia  
&  
KCI Technologies, Inc.

August, 2005

## TABLE OF CONTENTS

LIST OF TABLES AND FIGURES .....	ii
CHAPTER 1: INTRODUCTION .....	1-1
Evaluation of 2005 Water Quality Data.....	1-9
CHAPTER 2: PHOSPHORUS LOAD ESTIMATION.....	2-1
Regression Method .....	2-2
CHAPTER 3: HYDROLOGY AND WATER BUDGET .....	3-1
Methods and Hydrologic Inflows .....	3-2
Hydrologic Outputs.....	3-3
Change in Reservoir Storage .....	3-3
The Residual and Explanation of Errors .....	3-3
Water Budget .....	3-4
CHAPTER 4: REFERENCES .....	4-1
APPENDIX A - 2005 Tributary, Wetfall, and Dryfall Raw Data by Date .....	A-1
APPENDIX B - 2005 Reservoir Water Quality Data by Date .....	B-1
APPENDIX C - 2005 Reservoir Algae Data .....	C-1

## LIST OF FIGURES

Figure 1-1.	Map of Swift Creek Reservoir and Immediate Vicinity.....	1-3
Figure 1-2.	Total Annual Rainfall Recorded Estimated for Swift Creek Reservoir Watershed from 1985 – 2004 (Average 1985-2005) .....	1-8
Figure 2-1a.	Relationships of Total Flow verses Total Phosphorus Load in the Tributaries of Swift Creek Reservoir (Regression Method 2000) .....	2-3
Figure 2-1b.	Relationships of Total Flow verses Total Phosphorus Load in the Tributaries of Swift Creek Reservoir (Regression Method 2000) .....	2-4
Figure 2-1c.	Relationships of Total Flow verses Total Phosphorus Load in the Tributaries of Swift Creek Reservoir (Regression Method 2000) .....	2-5
Figure 2-2.	Annual Phosphorus Loadings to Swift Creek Reservoir.....	2-8
Figure 3-1.	Sub-basins and Data Collection Sites in the Swift Creek Drainage Basin..	3-6
Figure 3-2a.	2005 Discharge Hydrographs for the Western Tributaries of Swift Creek Reservoir Watershed.....	3-7
Figure 3-2b.	2005 Discharge Hydrographs for the Northern Tributaries of Swift Creek Reservoir Watershed.....	3-8
Figure 3-2c.	2005 Discharge Hydrographs for the Direct Runoff Sites and Impounded Waters of Swift Creek Reservoir Watershed .....	3-9
Figure 3-2d.	2005 Discharge Hydrographs for the Direct Runoff Sites and Impounded Waters of Swift Creek Reservoir Watershed .....	3-10
Figure 3-3	2005 Monthly Evaporation from Swift Creek Reservoir.....	3-22

## LIST OF TABLES

Table 1-1.	Land Use Characteristics of the Swift Creek Watershed .....	1-4
Table 1-2.	Sampling Regime for Swift Creek Reservoir and its Watershed (2005).....	1-6
Table 1-3.	Parameters and Analytical Methods.....	1-7
Table 1-4.	Growing Season Chlorophyll a Concentrations (ug/L) 2005 Reservoir Sampling...	1-11
Table 1-5.	Growing Season Median Total Phosphorus Concentrations 2005 Reservoir Sampling .....	1-12
Table 1-6.	Growing Season Medians.....	1-14
Table 1-7.	Annual Median Phosphorus Concentrations 2005 Tributary Sampling.....	1-15
Table 1-8.	Phosphorus Concentrations for Storm Events .....	1-16
Table 1-9.	Annual Median Nitrogen Concentrations 2005 Tributary Sampling.....	1-18
Table 2-1.	Sub-Basin Areas and Scaling Factors of Swift Creek Reservoir Watershed As Determined from Data by Smock (1993) and USGS (1998). ....	2-2
Table 2-2.	Results of the Wetfall – Dryfall Phosphorus Monitoring (2005) .....	2-6

Table 2-3.	Seasonal Atmospheric Total Phosphorus Inputs to Swift Creek Reservoir (2005).	2-6
Table 2-4.	Annual 2005 sub-basin phosphorus loads for Swift Creek Reservoir Watershed as determined by the Regression Method (Leitch, 1998) .....	2-7
Table 2-5.	Summary of Annual Phosphorus Loadings .....	2-9
Table 3-1.	2005 Water Budget for Swift Creek Reservoir.....	3-4
Table 3-2.	Drainage Area, Discharge and Runoff Data for Tributaries and Residential Catchments .....	3-5
Table 3-3a-k	2005 Daily Mean Discharges for Sites within the Swift Creek Reservoir Watershed .....	3-11
Table 3-4.	Drainage Area, Discharge and Runoff Data for Direct Runoff Areas .....	3-22
Table 3-5.	2005 Rainfall Gain to Swift Creek Reservoir .....	3-22
Table 3-6a-b	Spillway Overflow and Seepage Mean Daily Discharges.....	3-23
Table 3-7.	Monthly and Annual Evaporation Totals Determined at Swift Creek Reservoir .....	3-25
Table 3-8.	A Comparison of Water Budget Characteristics over the Past Eight Years .....	3-26

## **EXECUTIVE SUMMARY**

---

This report presents the water quality data collected by the Addison-Evans Laboratory Staff for the period of January through December 2005 and represents the thirteenth consecutive year of monitoring the Swift Creek Reservoir and its watershed. The report provides general water quality data, quantifies the phosphorus load and determines the water budget for the reservoir.

### ***Water Quality Monitoring***

Results of the 2005 monitoring indicated that overall water quality in the reservoir was very good with applicable parameters well below state standards. The median total phosphorus concentration for the reservoir was 0.021 mg/l TP, below the County's inlake goal (0.05 mg/l TP) and DEQ's pending freshwater nutrient standard (0.04 mg/l TP). The growing season 90<sup>th</sup> percentile Chlorophyll a concentration for the mainstem reservoir stations (*i.e.* Stations 4-8) was 10.3 ug/L, well below the pending DEQ freshwater standard of 35 ug/L. During the summer, all mainbody reservoir stations (4, 5, 6, 7 and 8) experienced dissolved oxygen below the DEQ standard of 5.0 mg/l at or near the bottom of the water column. The low dissolved oxygen observed in deeper waters is part of a natural thermal stratification process that occurs each summer in most lakes in Virginia.

The tributary water quality monitoring indicated a wide range of conditions among the watersheds. All of the tributaries typically experienced a median baseflow total phosphorus concentration of less than 0.03 mg/L. During storm flows, median concentrations ranged from 0.03 to 0.12 mg/L. Individual storm event results in the spring and fall from Westbranch (Station 2), Brandermill (13) and Woodlake (14) indicated elevated TP levels of between 0.15 and 0.24 mg/l TP. These elevated concentrations of TP in the fall at the Brandermill and Woodlake stations are consistent with observations from fall of 2004. Additionally, the high TP values observed at the Westbranch station during 2005 have been present since 2004.

The 2005 results from the nitrogen monitoring in the tributaries were very similar to those in 2004. In ninety percent of the samples, the Brandermill and Woodlake stations had the highest TN concentrations with concentrations well over 1.0 mg/l TN frequently observed. The likely source of the elevated nitrogen is lawn fertilizers applied in the spring and fall.

### ***Phosphorus Loadings***

The 2005 estimate of phosphorus loading (3,715 pounds) is the second lowest estimate since 1992, and is nearly 50% lower than the long-term median. This annual loading reflects the lower than average rainfall in 2005.

### **Water Budget**

The average rainfall over the watershed totaled 35.36 inches during 2005, which was below the long-term average of 41 inches. This decrease resulted in less rainfall directly onto the reservoir and reduced runoff from the surrounding watersheds. Runoff was the second lowest estimated since the start of the monitoring program. Total hydrologic input to the reservoir was 1485 Mft<sup>3</sup> and total output was 2197 Mft<sup>3</sup>. The water budget indicated a surplus of 716 Mft<sup>3</sup> of water leaving the reservoir which was not accounted for in the estimate of water inputs to the reservoir.

### **Overview**

Phosphorus and Chlorophyll a concentrations in the reservoir are acceptable and below pending state standards and the County goal. Some of the tributaries that have developed watersheds are exhibiting high concentrations of nutrients, which over time, may have a detrimental effect on the reservoir. Year 2005 had low rainfall resulting in reduced runoff and phosphorus loadings from the watershed. The phosphorus loadings (3,715 pounds) was the second lowest since the start of monitoring. While phosphorus loadings provide a relative gauge of impact to the reservoir, in lake monitoring is the most reliable and accurate method to track the actual nutrient condition of the reservoir and the ecological response of the water body to land use changes.

# **Chapter 1: Introduction**

## INTRODUCTION

---

This report presents the water quality data collected by the Addison-Evans Laboratory Staff for the period of January through December 2005 and represents the thirteenth consecutive year of monitoring of the Swift Creek Reservoir and its watershed. The objective of this report is to present past and present water quality conditions. Specifically, this report:

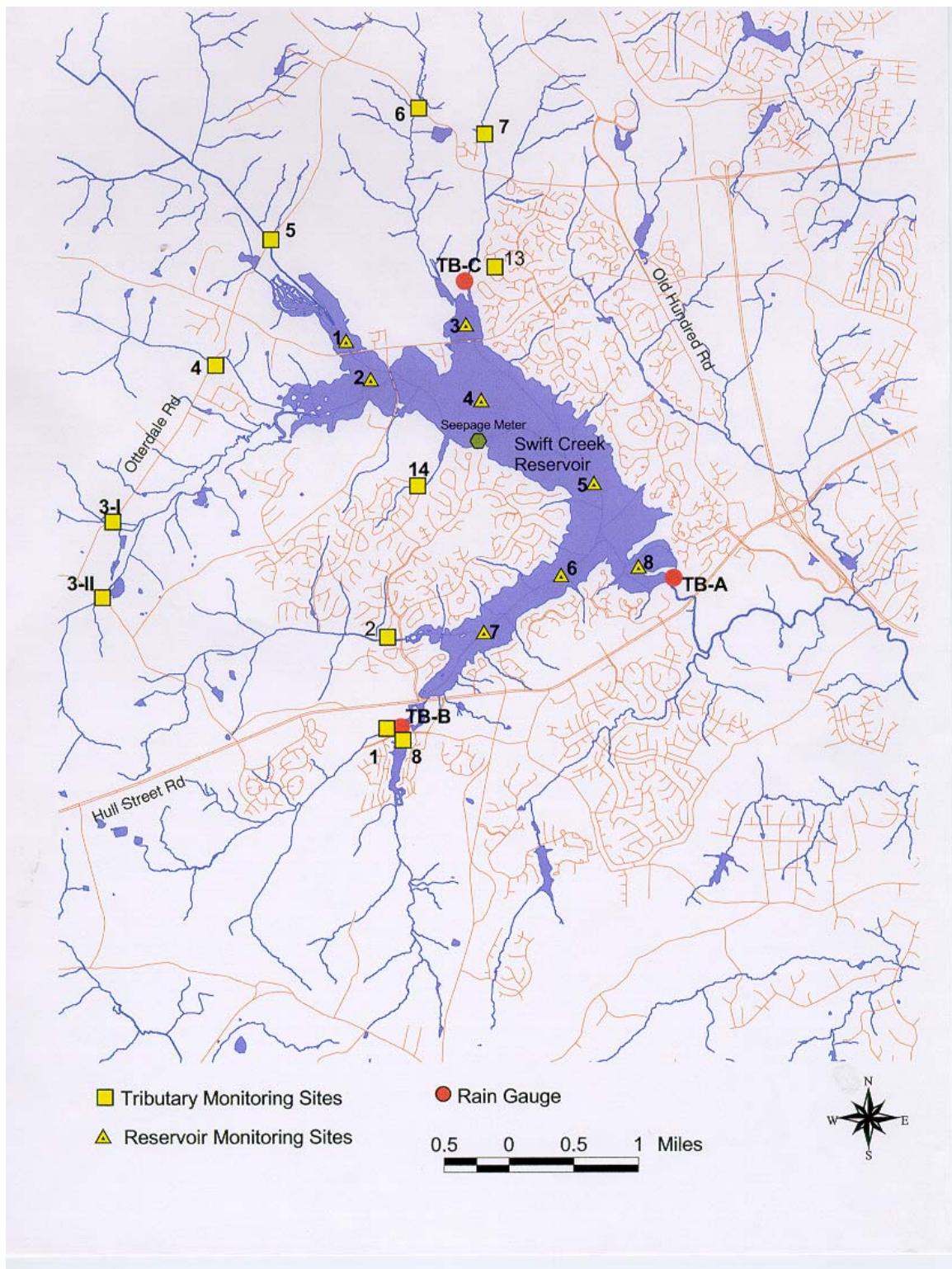
- 1) provides general water quality and biological data,
- 2) quantifies the phosphorus load, and
- 3) determines the water budget for Swift Creek Reservoir.

During 2005, pool elevations measured at the dam ranged from 174.7 to 177.3 feet above mean sea level, corresponding to approximate reservoir volumes of 3.23 and 4.55 billion gallons respectively. As in prior years, the reservoir exhibited thermal and dissolved oxygen stratification at its deeper areas beginning in April and lasting through September. Water quality samples were obtained at the established eight sites throughout the reservoir (Figure 1-1). Analyses performed are described in Tables 1-2 and 1-3.

Details regarding specific physical characteristics of the watershed and other attributes such as soil types have been outlined in previous reports (Hoehn *et al.*, 1998; SCWTP, 1999). Although residential development is common in the reservoirs drainage area, the most recent land use data (Table 1-1, from CH2M Hill, May 2000) found that 71.2% of the watershed was of undeveloped forests and pastures.

Monthly baseflow and periodic stormflow water quality samples were collected at nine tributary stations and at two permanent direct runoff sites within the watershed (Figure 1-1). Sites and identification numbers remained the same as in previous years, as outlined below:

Site 1 = Dry Creek	Site 4 = Otterdale Branch	Site 8 = Ashbrook Dam
Site 2 = Westbranch	Site 5 = Swift Creek	Site 13=Chimney House (Brandermill)
Site 3-I = Horsepen Creek	Site 6 = Tomahawk Creek	Site 14 = Chestnut Bluff (Woodlake)
Site 3-II = Blackman Creek	Site 7 = Little Tomahawk Creek	



**Figure 1-1. Map of Swift Creek Reservoir and Immediate Vicinity**

**Table 1-1**  
**Land Use Characteristics of the Swift Creek Watershed**  
**(from CH2M Hill, 2000)**

<u>Land Use Type</u>	<u>Area (acres)</u>	<u>Area (sq. miles)</u>	<u>Percent of Watershed</u>
Single Family Residential - Rural	5095	7.96	12.85
Single Family Residential - Semi-Rural	1001	1.56	2.53
Single Family Residential - Suburban Low Density	845	1.32	2.13
Single Family Residential - Suburban Medium Density	888	1.39	2.24
Single Family Residential - Suburban High Density	494	0.77	1.25
Multi-Family Residential	73	0.11	0.18
Community Mixed Use	567	0.89	1.43
Regional Mixed Use	31	0.05	0.08
Major Thoroughfares	1107	1.73	2.79
Industrial	29	0.05	0.07
Cropland	1085	1.70	2.74
Pastureland	905	1.41	2.28
Forest	26,831	41.92	67.68
Grass	510	0.80	1.29
Water	181	0.28	0.46
Conservation, Passive Recreation	0	0.00	0.00
Total	39,642	61.94	100.00

Reservoir sampling occurred once a month throughout the year at all 8 stations with additional samples obtained every other week at the lacustrine zone sites (5 and 8). At these deeper water sites, discrete epilimnion, metalimnion, and hypolimnion samples were taken for nutrient analysis. The shallower sites in the reservoir, stations 1, 2, 3, 4, 6 and 7, were sampled at the surface only.

Water quality parameters (Table 1-2) were chosen to provide information on basic water quality and the ecological health of the reservoir and its tributaries. Analysis procedures are listed in Table 1-3. Greater detail on sampling and analytical methods can be found in the 1997 report of reservoir water quality (SCWTP 1999).

Rainfall was measured at three automated rain gages within the watershed. The average rainfall over the watershed totaled 35.36 inches during 2005 (Figure 1-2). Due to equipment issues during part of the summer, precipitation data from the NOAA weather station at Winterpock was used. High rainfall leads to more runoff in the watershed and consequently higher phosphorus loading and shorter hydraulic residence times in a given year.

#### ***Quality Assurance and Quality Control:***

All analytical methods used were EPA approved, in accordance with *Standard Methods for the Examination of Water and Wastewater* (Standard Methods) with the exception of free ammonia analyses which were made following the Hach Chemical Company's test kit procedure (Table 1-3).

For each parameter analyzed, Method Detection Limits (MDL) were calculated following the EPA procedure as detailed in the *Code of Federal Regulations (CFR), Volume 46, Part 136 Appendix B* (EPA, 1984). Stock and standard solutions were prepared from American Chemical Society reagent grade materials for preparation of calibration standards. Correlation coefficients were evaluated for each calibration curve and had to be greater than or equal to 0.995 to be used for analysis. To ensure calibration validity throughout an analysis, Continuing Calibration Verifications (CCV) standards were tested after every 10 samples analyzed. Similarly, Continuing Calibration Blanks (CCB) were evaluated after every 10 samples to detect any baseline drift errors. With each analysis, field blanks and digestion/analytical blanks were evaluated to ensure detection of contamination during sampling or sample preparation. Independent source Standard Reference Materials (SRM) were purchased and used to verify the accuracy of each analysis calibration. When any standard (or SRM) was not within 10 percent (per EPA guidelines) of the true value, or CCB showed baseline drift, corrective actions were implemented and samples were reanalyzed.

**Table 1-2. Sampling Regime for Swift Creek Reservoir and its Watershed (2005)**

<u>PARAMETERS</u>	<u>STORM</u>	<u>TRIBUTARY</u>	<u>RESERVOIR</u>	<u>RESERVOIR</u>	<u>WETFALL</u>
	<u>EVENT</u>	<u>BASE FLOW</u>	<u>SITES 1,2,3,4,6,7,8</u>	<u>SITES 5,8</u>	<u>DRYFALL</u>
DEPTH			X1	X1	
FLOW	X	X			
SECCHI DISC			X	X	
WATER TEMPERATURE	X	X	X1	X1	
DISSOLVED OXYGEN (Given as mg/L & % saturation)	X	X	X1	X1	
CONDUCTIVITY	X	X	X1	X1	
pH	X	X	X1	X1	X
OXIDATION REDUCTION POTENTIAL			X1	X1	
TOTAL PHOSPHORUS	X	X	X2	X3	X
ORTHO PHOSPHATE PHOSPHORUS	X	X	X2	X3	X
TOTAL KJELDAHL NITROGEN	X	X	X2	X3	X
OXIDIZED NITROGEN	X	X	X2	X3	X
AMMONIA NITROGEN			X2	X4	
TOTAL ORGANIC CARBON	1/QTR	1/QTR	X2, 1/QTR	X2, 1/QTR	
LEAD	1/QTR	1/QTR	X2, 1/QTR	X2, 1/QTR	
ZINC	1/QTR	1/QTR	X2, 1/QTR	X2, 1/QTR	
SUSPENDED SOLIDS/TURBIDITY	X	X	X2	X2	
CHLOROPHYLL a			X5	X5	
PHEOPHYTIN a			X5	X5	
ALGAE COUNTS			X5	X5	
FECAL COLIFORMS	X	X	X2	X2	

X1 - ONE METER INTERVALS

X2 - SURFACE SAMPLING ONLY

X3 - DISCRETE SAMPLES OF EPILIMNION, METALIMNION, METALIMNION, AND HYPOLIMNION WHEN STRATIFICATION EXISTS OR SURFACE, MID-DEPTH, AND NEAR BOTTOM WHEN NO STRATIFICATION PRESENT

X4 - DISCRETE SURFACE AND NEAR BOTTOM SAMPLES

X5 - A COMPOSITE OF BENEATH SURFACE, ½ SECCHI DEPTH, AND 1-1/2 SECCHI DEPTH SAMPLES

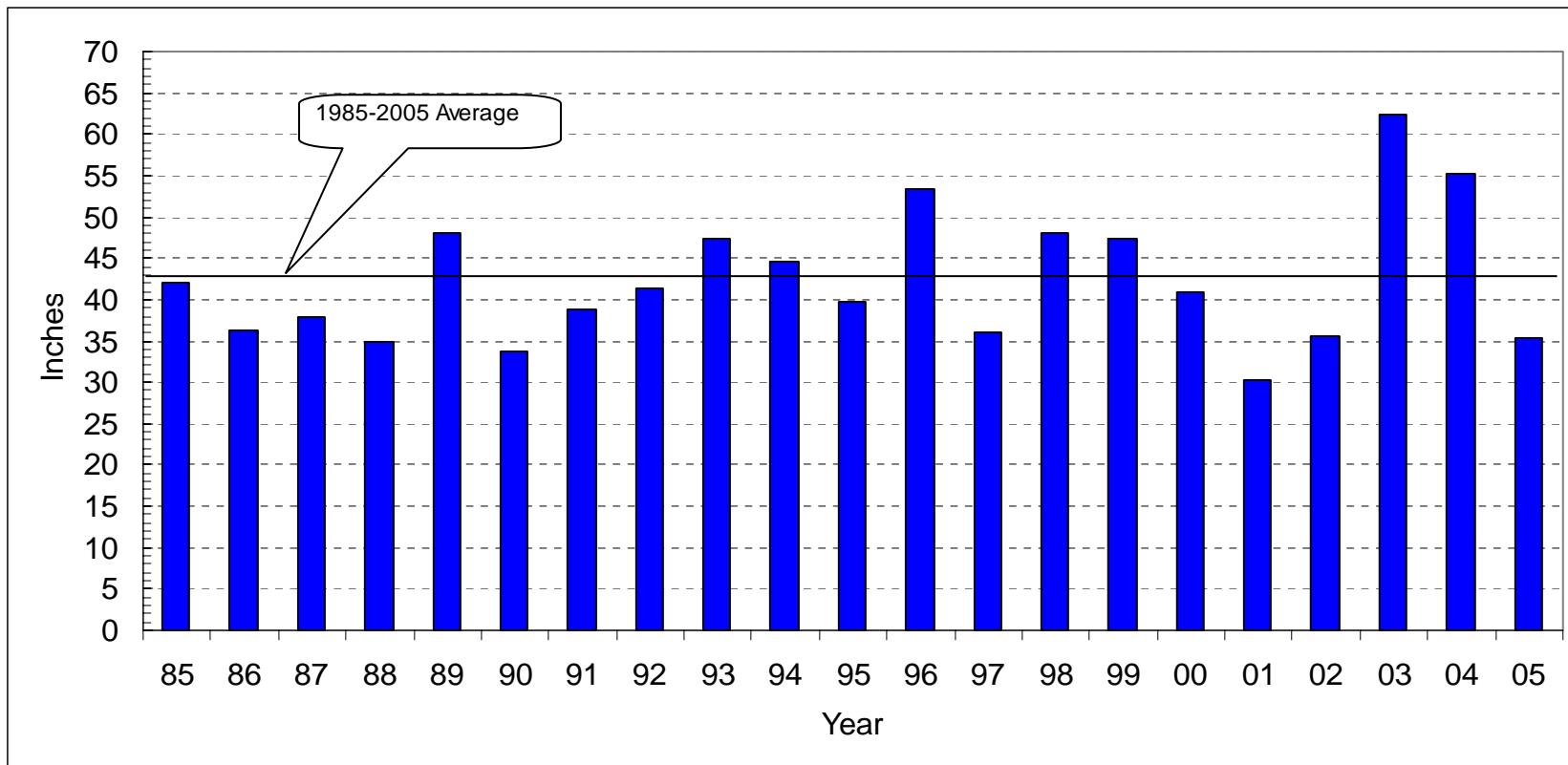
**Table 1-3. Parameters and Analytical Methods**

Parameter	Analytical Method	Detection Limit <sup>1</sup>
Depth Dissolved Oxygen Oxidation Reduction Potential Water Temperature Conductivity pH	Probe: Hydrolab MiniSonde Probe: Hydrolab MiniSonde Probe: Hydrolab MiniSonde Probe: Hydrolab MiniSonde Probe: Hydrolab MiniSonde Probe: Hydrolab MiniSonde Probe: Hydrolab MiniSonde	± 0.08 m* ± 0.2 mg/L* ± 20mV* ± 0.1 °C* ± 0.001 µmhos/cm* ± 0.2 units*
Stage Flow Secchi Depth	USGS Staff Gauge Flowmeter: ISCO, Bubble-line 20 cm Standard Secchi Disk	± 0.01 ft* ± 0.001m <sup>3</sup> /s* ± 0.1 ft*
Total Phosphorus Orthophosphate Total Kjeldahl Nitrogen Oxidized Nitrogen Ammonia-N Total Organic Carbon	Skalar:EPA Approved, Autom. Skalar:EPA Approved, Autom. Skalar:EPA Approved, Autom. Skalar:EPA Approved, Autom. Hach, Salicylate Method 2460 Standard Methods, 5310C	0.005 mg/L 0.005 mg/L 0.05 mg/L 0.01 mg/L 0.03 mg/L 0.5 mg/L
Lead Zinc Total Suspended Solids	EPA 200.9, Platform Furnace EPA 289.1, Flame Standard Methods, 2540D	2.5 µg/L 50 µg/L 1.0 mg/L
Chlorophyll a Pheophytin Algae Counts Fecal Coliform Density Macroinvertebrate Assessments	Standard Methods, 10200H-3, Fluorom. Standard Methods, 10200H-3, Fluorom. Standard Methods, 10200F Standard Methods, 9222B EPA Rapid Bioassessment Protocol II	1.0 µg/L 1.0 µg/L 1 cell/mL 100col/mL N/A
Stream Gauging	USGS methodology	0.01 cfs*

**NOTE:** Standard Methods for the Examination of Water and Wastewater, 19th Edition.

\* When Reporting Limit based upon detection is not an applicable measurement for a parameter, it has been replaced by an estimation of accuracy (e.g. pH measurement has an estimated accuracy of 0.2 units).

**Figure 1-2. Total Annual Estimated Rainfall Recorded for Swift Creek Reservoir Watershed from 1985-2004.  
(Average 1985-2005)**



An EPA performance evaluation of blind nutrient samples in a split sampling study is performed annually. Reported concentrations for orthophosphate and total phosphorus, ammonia, oxidized nitrogen, and total Kjeldahl nitrogen continue to be within the limits of the EPA's acceptable analytical values. The nutrient concentrations of the blind samples are of a higher concentration than normally found in our survey program samples. However, as of yet we are not aware of any SRM manufacturer who provides blind samples of lower concentration.

Manufacturers' recommended preventive maintenance procedures were followed for all instruments.

All water quality data can be found in Appendices A and B. Algal data can be found in Appendix C.

## **EVALUATION OF 2005 WATER QUALITY DATA**

KCI Technologies, Inc. provided an assessment of the 2005 water quality data with limited comparisons to historical data collected under this program.

### **Reservoir Water Quality Data Assessment**

The eight stations in the reservoir were sampled at least monthly. Stations 8 and 5 were sampled twice per month. Sampling included surface water quality grab samples, a profile of physical parameters, and bottom water quality samples.

The county's current water quality goal for annual median concentration of total phosphorus (TP) in surface waters is 0.05 mg/L or less. This goal was based on a Nutrient Controls Standards Workshop held in 1987 by the Department of Environmental Quality (formerly the State Water Control Board). This goal was the best available information for a nutrient standard for a reservoir.

In June, 2006, DEQ adopted freshwater nutrient standards for 116 lakes and reservoirs in Virginia, including Swift Creek Reservoir. The regulations are awaiting approval of EPA. The regulations set Chlorophyll a and TP criteria for Swift Reservoir at 35 ug/L (0.035 mg/L) and 40 ug/L (0.040 mg/L), respectively. DEQ would consider the reservoir nutrient enriched if the 90<sup>th</sup> percentile of the chlorophyll a data in surface waters of the main body of the reservoir (Stations 4-8) exceeded the criteria for two consecutive years. If algicides were being used, thus making the chlorophyll a measurements unreliable, then both Chlorophyll a and TP criteria would be used. DEQ would consider the reservoir nutrient enriched if the median concentration of TP in surface waters of the main body of the reservoir exceeded the criteria for two consecutive years.

In Swift Creek Reservoir, algicides are used to spot treat algal blooms, so chlorophyll a measurements could be depressed. Algicide use is variable over the reservoir between months and between years. Because of the algicide use, analysis of the reservoir data should include both TP and Chlorophyll a criteria.

During 2005, approximately 3,000 pounds of copper sulfate was used over eight separate occasions to treat algae blooms in the reservoir. The water intake tower bay was treated six times, the Woodlake shoreline once, the Hull Street shoreline area once. The amount of copper sulfate used in 2005 was 50% greater than 2004. Data from Station 8 would be the most affected by the algicide applications. However, there should be little to no impact on data from the other stations.

### ***Chlorophyll a***

DEQ has identified Chlorophyll a as the most important parameter that can be measured to determine the nutrient enrichment status of a reservoir. Chlorophyll a, a green plant pigment found in algae, is a direct measure of biological response to nutrient loadings. DEQ considers the threshold values for nutrient enrichment at Swift Creek Reservoir to be 90<sup>th</sup> percentile concentrations that exceed 35 ug/L, between April and October (i.e. the growing season).

The growing season 90<sup>th</sup> percentile concentration for the mainstem reservoir stations (i.e. Stations 4-8) was 10.3 ug/L, which is well below the 35 ug/L threshold. All of the stations in the reservoir had 90<sup>th</sup> percentile concentrations during the growing season of 11.7 ug/l. There were individual measurements in October which were between 20 and 30 ug/l, but none exceeded the standard. During 2005, the reservoir exhibited nutrient enrichment well below the state standard based on measurements of chlorophyll a concentrations. Of the mainstem stations, Station 6 has a higher 90<sup>th</sup> percentile concentration, primarily due to a single high value in October. Stations 1, 2 and 3, which are considered near shore stations, have higher 90<sup>th</sup> percentile concentrations than most of the mainstem stations.

There were seasonal patterns to the concentrations of Chlorophyll a in the reservoir. January, 2005 was relatively high, but this could be a carry over effect from the high concentration in the fall and early winter of 2004 due to Tropical Storm Gaston. There were increased Chlorophyll a concentrations in the fall over most of the stations. Increased concentrations were seen in September at Station 3, and in October at Stations 1, 2, 5, 6, 7, and 8.

**Table 1-4. Growing Season Chlorophyll a Concentrations (ug/L)**  
**2005 Reservoir Sampling**

	4/14	4/28	5/11	5/26	6/6	6/20	7/6	7/18	8/3	8/18	9/6	9/19	10/4	10/18	90 <sup>th</sup> Percentile	MAXIMUM
<b>Site 1</b>	2.3		1.1		2.2		*			*	*		23.5		17.1	23.5
<b>Site 2</b>	3.0		1.0		1.4		*			*	*		19.4		14.5	19.4
<b>Site 3</b>	4.3		3.2		2.3		6.0			11.6	18.2		9.2		14.2	18.2
<b>Site 4</b>	7.2		2.1		1.4		1.1			11.8	4.1		5.9		9.0	11.8
<b>Site 5</b>	6.8	9.1	3.3	5.6	3.9		1.0	2.8	3.2	8.5	4.7	8.8	11.3	8.8	9.0	11.3
<b>Site 6</b>	6.2		5.5		10.0		1.4			6.5	4.8		26.3		16.5	26.3
<b>Site 7</b>	5.3		6.1		0.9		0.3			4.8	5.0		12.4		8.6	12.4
<b>Site 8</b>	6.5	6.2	4.6	9.0	7.7	5.0	1.2	4.2	2.0	3.4	3.6	8.6	21.5	9.2	9.1	21.5
<b>Date MEDIAN</b>	<b>5.8</b>	<b>6.2</b>	<b>3.3</b>	<b>7.3</b>	<b>2.3</b>	<b>5.0</b>	<b>1.2</b>	<b>3.5</b>	<b>2.6</b>	<b>7.5</b>	<b>4.8</b>	<b>8.7</b>	<b>15.9</b>	<b>9.0</b>	<b>11.7</b>	<b>26.3</b>

\*=no sample collected due to low water levels.

### **Total Phosphorus (TP in mg/L)**

Total phosphorus is often measured as an indicator of nutrient enrichment. The County has a goal of 0.05 mg/L in order to maintain water quality. DEQ has proposed a freshwater nutrient standard of 40 ug/L (i.e. 0.040 mg/L) for the growing season. Both of these criteria are useful in assessing the nutrient enrichment status of the reservoir. The growing season (April – October) average TP concentrations for each reservoir station are provided in the following table:

**Table 1-5. Growing Season Median Total Phosphorus Concentrations  
2005 Reservoir Sampling**

STATION	GROWING SEASON MEDIAN TOTAL PHOSPHORUS (mg/L as P)
1	0.021
2	0.021
3	0.032
4	0.017
5	0.021
6	0.013
7	0.024
8	0.024
<b>All Stations</b>	<b>0.021</b>

The reservoir is below the County goal and DEQ freshwater nutrient standards indicating good water quality. The majority of individual stations and the reservoir as a whole have median growing season TP concentrations that are well below the standard. However, there were individual measurements of TP that were above the 0.05 mg/L goal and the DEQ standard. While individual measurements that exceed the TP goal or DEQ standard are to be expected, the location and pattern of these exceedances may highlight pollutant sources or processes. In 2005, 13% of the individual measurements exceeded the DEQ standard. Station 8 had the greatest number of individual exceedances (3 out of 13). The Station 3 median growing season TP concentration was 0.032 mg/L, or approximately 50% greater than the other stations. Station 3 is located near the inflow from Tomahawk and Little Tomahawk Creeks, which have experienced accelerated development in 2005. Station 3 is a near shore station, and would not be considered in the DEQ standard.

A significant increase in TP in anoxic, or oxygen depleted, bottom waters indicates active phosphorus release from the sediments. The potential sediment release of phosphorous would result in an additional loading to the reservoir, as this phosphorous is mixed with the upper water layers during de-stratification. The deepest stations (5 and 8) showed minor signs of a benthic release of phosphorus, but it was infrequent and TP concentrations were not much greater than the surface concentrations. During 2005, this potential source of additional phosphorous loadings did not appear to be significant. The frequency, magnitude and extent of elevated TP concentrations in bottom waters should be evaluated over time to determine if this source of phosphorus is becoming more prevalent.

### ***Dissolved Oxygen***

For non-tidal freshwaters the state standard needed to support aquatic life is a daily average of 5.0 mg/L of dissolved oxygen. Hypoxic conditions (low oxygen levels) occur when dissolved oxygen drops below 5 mg/L, resulting in stress on fish and other aquatic life. An anoxic condition (a lack of oxygen) occurs below 1 mg/L, and can result in fish kills, and the release of phosphorus, iron, manganese, and other elements from the sediments. These elements can result in increased algal blooms, and odor/taste and treatment problems for drinking water.

Thermal stratification is a natural process in many lakes and reservoirs that occurs when summer conditions warm the upper water column. The surface waters become lighter than the colder and denser bottom waters, resulting in two layers of water separated by a zone of sharply changing temperature (i.e. thermocline) that inhibits vertical mixing. The thermal stratification typically continues until falling temperatures cool the surface water sufficiently to break up the thermocline. Often a large fall storm event will result in a rapid de-stratification of the lake.

Thermal stratification started in Swift Creek Reservoir in early June at Station 5, 6 and 8 showing both a thermocline and a significant drop in dissolved oxygen. During the summer, all of the main reservoir stations (4, 5, 6, 7 and 8) experienced dissolved oxygen below the DEQ standard of 5.0 mg/l, and stations 5 and 8 regularly experienced anoxic conditions or a nearly total lack of oxygen. The most extreme conditions were reached at Station 8 in August, when 10 feet of the lower water column was anoxic -- incapable of supporting life. Stratification continued into September, when the water column mixed. However, low oxygen levels were recorded well into the fall at some stations.

During periods of low dissolved oxygen organic material in the sediment can breakdown, releasing ammonia, which can be toxic to aquatic life. On several occasions at Station 8, there were elevated ammonia concentrations near the bottom of the water column.

DEQ has recently proposed to EPA that the dissolved oxygen standard be modified to account for naturally occurring decreases in dissolved oxygen due to thermal stratification in reservoirs. The standards would apply to the entire water column when the reservoir is well mixed and only to the surface waters (epilimnion when the water column is vertically stratified). Swift Creek Reservoir is listed on the EPA 303(d) listing of impaired water bodies for not meeting the dissolved oxygen standard due to naturally occurring conditions. The revision of the state standards would remove Swift Creek from the EPA 303(d) listing of impaired waterbodies.

#### ***Secchi Disk, Total Suspended Solids and Turbidity***

Most stations had a median Secchi disk reading of 3.5 to 4.0 feet. Station 3 had a median Secchi disk reading of 2.65 or approximately 1 foot shallower during the growing season. The Chlorophyll a concentrations at Station 3 were similar to the other stations, but the growing season median Total Suspended Solids and Turbidity at Station 3 were higher. The lower Secchi depths at Station 3 may be reflecting a higher suspended sediment concentration. However, Station 3 also has higher TP concentrations compared to the other reservoir stations.

**TABLE 1-6 GROWING SEASON MEDIANs**

	SECCHI DISK	TOTAL SUSPENDED SOLIDS	TURBIDITY	CHLOROPHYLL a
STATION	(Feet)	(mg/L)	(ntu)	(ug/l)
1	3.7	4.8	6.8	2.2
2	3.7	5.8	6.7	2.5
3	2.7	7.4	8.1	6.0
4	3.5	5.6	5.5	5.0
5	3.8	4.1	4.8	6.0
6	3.6	3.8	5.1	5.9
7	3.5	5.0	5.5	5.2
8	4.1	3.8	4.1	6.4

#### **Tributary Water Quality Data Assessment**

DEQ is developing freshwater nutrient criteria for streams and rivers, which may be finalized in 2007. While there are currently no nutrient standards or criteria specific to streams, the TP criteria used for reservoirs provides a guideline against which to compare the tributary data.

### **Total Phosphorus**

The County has a reservoir concentration goal of 0.05 TP mg/L in order to maintain water quality. In order to achieve this threshold, the phosphorus concentrations in the tributaries, which are main sources of phosphorus to the reservoir, should be tracked over time to identify increasing trends in concentrations and loadings. Not all TP is biologically available; some of it is bound to sediment particles. Orthophosphate is the dissolved phosphorus component available in the water column to support biological activity, which includes algae blooms.

The tributaries typically experience a median baseflow TP concentration of less than 0.03 mg/L, and a storm flow concentration of between 0.03 and 0.12 mg/L.

**Table 1-7. Annual Median Phosphorus Concentrations  
2005 Tributary Sampling**

STATION	WATERSHED	TOTAL PHOSPHORUS(mg/L as P)		ORTHOPHOSPHATE PHOSPHORUS(mg/L as P)	
		Baseflow	Stormflow	Baseflow	Stormflow
1	Dry Creek	0.020	0.067	0.008	0.015
2	Westbranch	0.013	0.120	0.010	0.023
3-I	Horsepen	0.009	0.030	0.006	0.009
3-II	Blackman	0.015	0.048	0.011	0.011
4	Otterdale	0.014	0.034	0.006	0.013
5	Swift	0.020	0.046	0.014	0.012
6	Tomahawk	0.011	0.055	0.005	0.010
7	Lt. Tomahawk	0.027	0.013	0.005	0.018
8	Ashbrook Dam	0.031	0.040	0.005	0.007
13	Bandlermill	0.011	0.050	0.008	0.012
14	Woodlake	0.012	0.055	0.008	0.008
<b>Median</b>		<b>0.014</b>	<b>0.048</b>	<b>0.008</b>	<b>0.012</b>

**Table 1-8. Phosphorus Concentrations for Storm Events**

Station	Watershed	3/08/05	3/28/05	10/13/05
		TP (mg/L)	TP (mg/L)	
1	Dry Creek	0.026	0.069	0.027
2	Westbranch	0.053	0.118	0.218
3-i	Horsepen	0.026	0.026	ns
3-ii	Blackman	0.038	0.048	ns
4	Otterdale	0.029	0.029	0.037
5	Swift	0.027	0.31	0.042
6	Tomahawk	0.093	0.199	0.073
7	Lt. Tomahawk	0.078	0.369	0.13
8	Ashbrook Dam	0.023	0.039	ns
13	Brandermill	0.175	0.184	0.123
14	Woodlake	0.235	0.265	0.216

During March of 2005, storm sampling recorded a pulse in phosphorus concentrations from several watersheds. Stations 13 and 14 were consistently high during both storm events. Lt. Tomahawk had high phosphorus concentrations which may reflect the very high TSS concentrations (1600 mg/l) during the 3/28<sup>th</sup> storm. In most cases during these storm events, the stations with the highest TSS concentrations had the highest TP concentrations, indicating that a substantial amount of the phosphorous was probably attached to sediment particles in the storm flows. During October, 2005, TP concentrations were again high at stations 2, and 7, reflecting in part high total suspended solids. However, Stations 13 and 14 which also had high TP results, had significantly lower TSS concentrations, perhaps indicating the phosphorus was from a different source, potentially fertilizers during spring and fall lawn care season. The TP concentrations at Stations 13 and 14 are significantly over the 0.05mg/l TP goal for the reservoir. Since the developed area around the reservoir is the second largest drainage area to the reservoir, these high TP concentrations also represent a high loading to the reservoir.

The above results indicate that developed areas are contributing a significantly higher concentration of P to the reservoir than are the undeveloped watersheds. A substantial amount of the TP during the above storm events appeared to be associated with high suspended solids. Sediment and potentially fertilizers may be significant sources of phosphorous in these watersheds.

### **Nitrogen**

While phosphorus tends to be the primary nutrient of concern in freshwater monitoring programs, increased levels of nitrogen can also indicate degradation in water quality. Oxidized nitrogen, primarily nitrate, if elevated, may indicate inputs of fertilizers. Nitrate can be carried by both surface runoff and groundwater. Total Kjeldahl Nitrogen includes organic nitrogen and ammonia ( $\text{NH}_4$ ), which may be high if there are loadings of organic pollutants or ammonia based fertilizers. Total Nitrogen (TN) is the combined concentrations of Oxidized nitrogen and Total Kjeldahl Nitrogen.

The majority of the stations have baseflow median TN concentrations of less than 0.45 mg/L. Station 14 (Woodlake) has a baseflow median of 0.74 mg/L TN, almost double the concentration of the other stations. Station 13 (Brandermill) also experiences elevated TN concentrations compared to the majority of the other stations.

During storm events, the TN concentrations at the majority of the tributary stations increase as much as 50 % over the baseflow concentrations. Median TN concentrations during storms at Stations 2, 13 and 14 were 0.90, 0.93 and 1.48 mg/L, respectively, which is well above the other tributary stations. Station 14 consistently had the highest TN concentrations during most months of the year.

Stations 13 and 14 had substantially higher oxidized nitrogen concentrations consistently through out the year in both baseflow and stormflows. Compared to stations such as 3-1 (Horsepen) or 4 (Otterdale), which are relatively undeveloped, Station 14 had oxidized nitrogen concentrations that were an order of magnitude higher (10 times higher). Stations 2 (Westbranch), 6 (Tomahawk), 7 (Little Tomahawk), and 13 (Brandermill) also had elevated oxidized nitrogen concentrations compared to the other watersheds, but levels were lower than those of Station 13 and 14.

The 2005 results from the nitrogen monitoring in the tributaries are very similar to those in 2004, when Station 13 and 14 consistently recorded elevated nitrogen concentrations. In 90 percent of the samples, Station 14 or 13 had the highest TN concentrations. In many cases, the concentrations were well over 1.0mg/l TN.

Major sources of oxidized nitrogen include fertilizers used in agriculture, residential, and

commercial landscaping. Fertilizers used on residential lawns appear to be the primary source at Stations 13 (Brandermill) and 14 (Woodlake), and possibly also at Station 2 (Westbranch), 6 (Tomahawk) and 7 (Little Tomahawk) resulting from the high percentage of residential landuse in their watersheds.

**Table 1-9. Annual Median Nitrogen Concentrations  
2005 Tributary Sampling**

STATION	TOTAL NITROGEN (mg/L as N)		TOTAL KJELDAHL NITROGEN (mg/L as N)		OXIDIZED NITROGEN (mg/L as N)	
	Baseflow	Stormflow	Baseflow	Stormflow	Baseflow	Stormflow
1	0.41	0.65	0.34	0.44	0.05	0.16
2	0.43	0.90	0.33	0.45	0.12	0.37
3-I	0.28	0.38	0.28	0.35	0.01	0.07
3-II	0.29	0.39	0.29	0.38	0.02	0.02
4	0.41	0.47	0.30	0.41	0.05	0.05
5	0.42	0.46	0.28	0.40	0.06	0.05
6	0.45	0.61	0.29	0.39	0.14	0.21
7	0.41	0.30	0.31	0.40	0.10	0.24
8	0.39	0.53	0.36	0.44	0.08	0.04
13	0.58	0.93	0.36	0.37	0.37	0.59
14	0.74	1.48	0.22	0.40	0.42	0.86

# **Chapter 2: Phosphorus Load Estimation**

## PHOSPHORUS LOAD ESTIMATION

---

### REGRESSION METHOD

The Regression method (Leitch, 1998) was used to determine phosphorus loadings to Swift Creek Reservoir. This regression method utilizes the relationship between the logarithms of tributary total stormflow or baseflow volume ( $\text{ft}^3$ ) and storm or baseflow total phosphorus load (pounds) to derive the annual total phosphorus load from the individual tributaries (See Figures 2-1a through 2-1c). This relationship has been determined by Leitch (1998) to most accurately represent the annual total phosphorus loading to Swift Creek Reservoir due to the pairing of actual baseflow and stormflow concentrations with their associated discharges. A modified version of the Leitch (1998) method (SCWTP 2000) was used for tributary and direct run-off phosphorus load estimations with scaling factors determined by Smock (1993) and USGS (1998) (Table 2-1).

**Table 2-1. Sub-Basin Areas and Scaling Factors of Swift Creek Reservoir Watershed as Determined from Data by Smock (1993) and USGS (1998)**

Site Name	Site Number	Gauged Area USGS (sq. miles)	Total Adjusted Area (sq. miles)	Scaling Factor
<b>Tributaries</b>				
Dry Creek	1	2.96	3.85	1.30
Westbranch	2	2.75	2.75	1.00
Horsepen Creek	3-I	3.72	4.39	1.18
Blackman Creek	3-II	5.80	6.61	1.14
Otterdale Branch	4	3.59	4.63	1.29
Swift Creek	5	21.40	23.27	1.09
Tomahawk Creek	6	4.20	5.94	1.41
Little Tomahawk Creek	7	2.31	3.21	1.39
Ashbrook Creek	8	2.37	2.56	1.08
<b>Direct Runoff</b>				
Chimney House Place	13	0.05	2.54	50.80
Chestnut Bluff Terrace	14	0.19	2.12	11.16

Baseflow total phosphorus loads were determined from grab sample concentrations and corresponding instantaneous discharges scaled to a 24 hour period (daily load). Storm event phosphorus concentrations were acquired by flow-weighted composite sampling of stormflows at each tributary and direct runoff site. The total flow volume was then applied to the event mean concentration (mg/L) of the storm to determine the event phosphorus load.

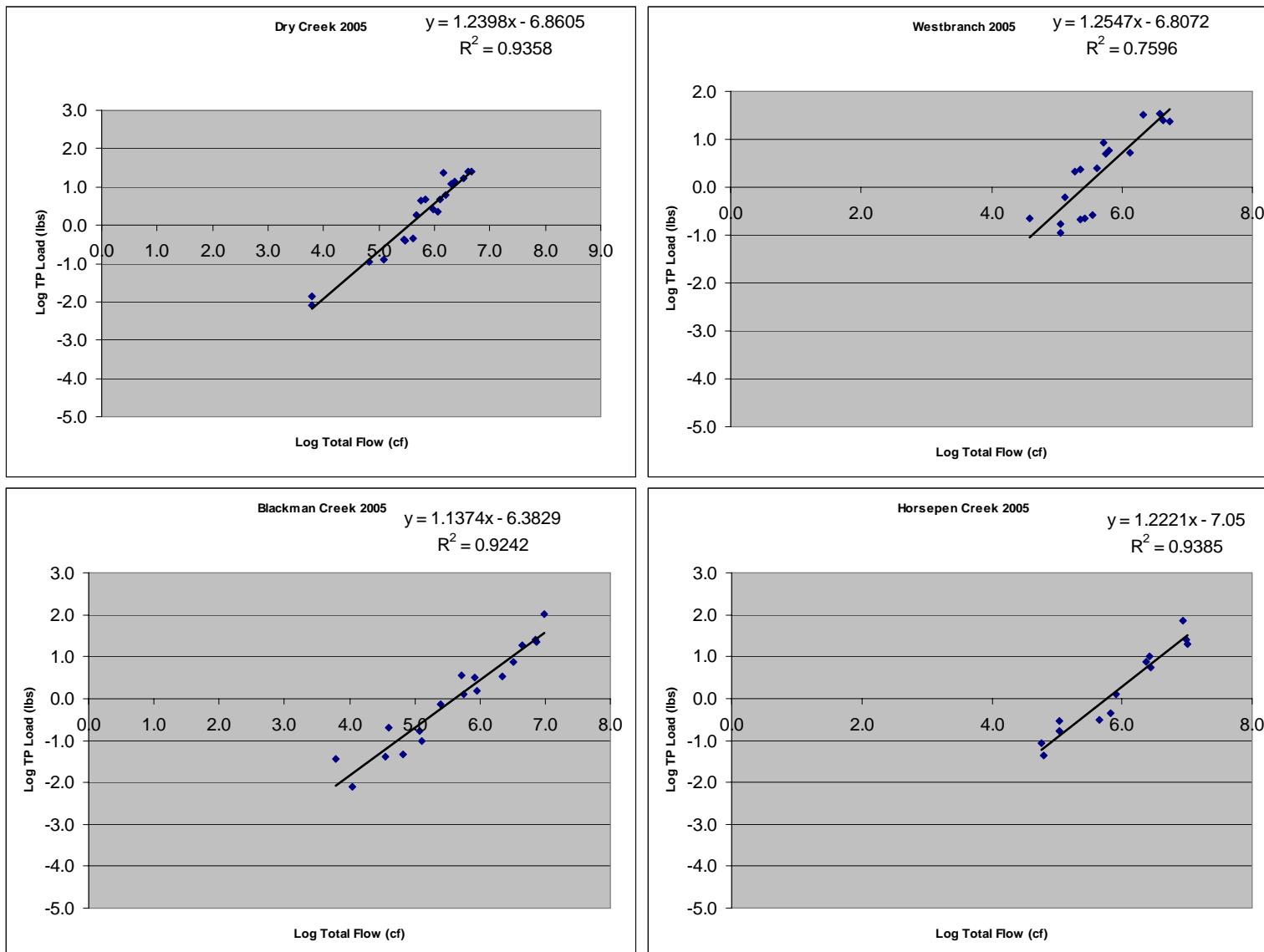


Figure 2-1a Relationships of Total Flow versus Total Phosphorus Load in the Tributaries of Swift Creek Reservoir (Regression Method 2000)

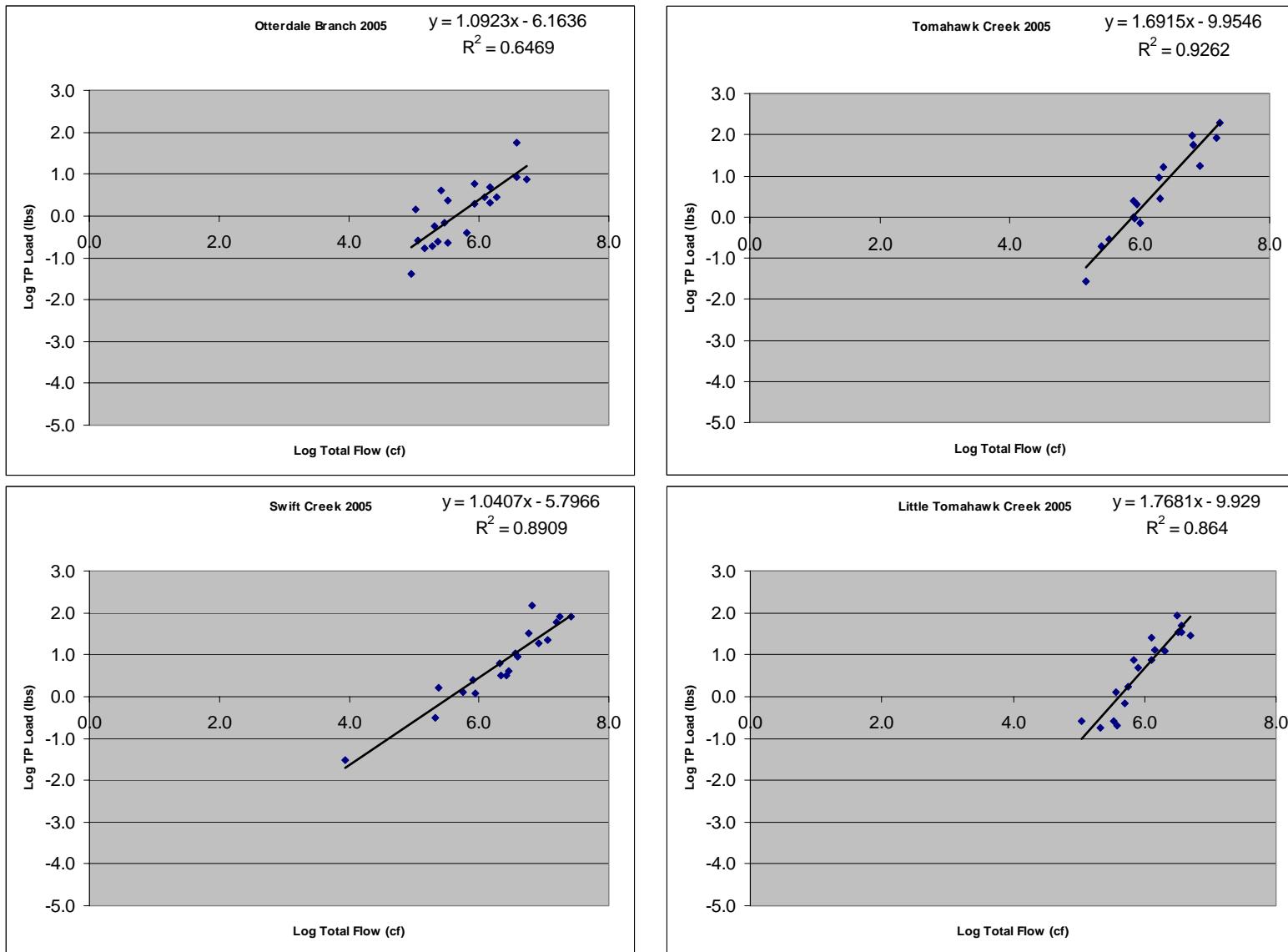


Figure 2-1b Relationships of Total Flow versus Total Phosphorus Load in the Tributaries of Swift Creek Reservoir (Regression Method 2000)

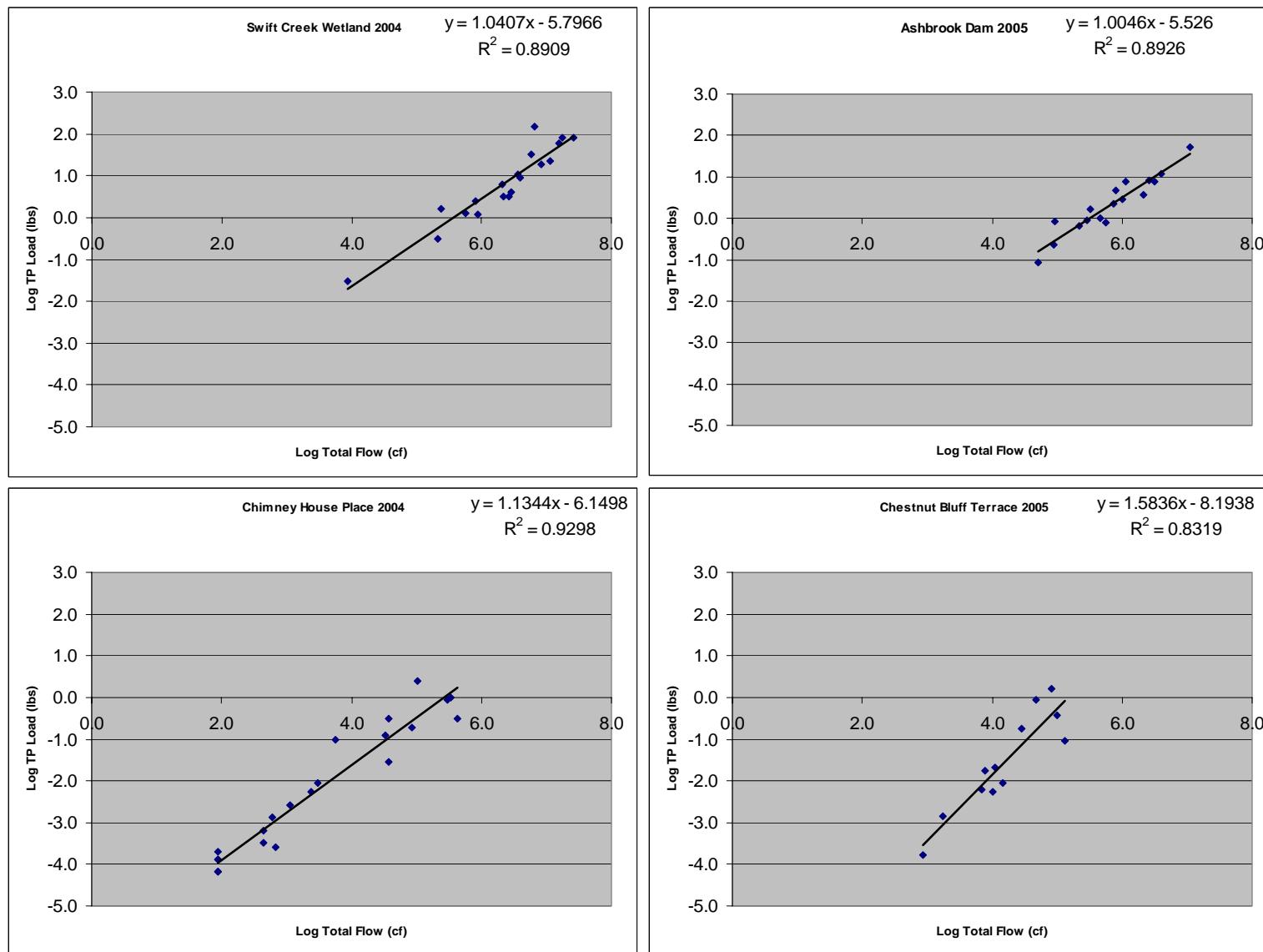


Figure 2-1c Relationships of Total Flow versus Total Phosphorus Load in the Tributaries of Swift Creek Reservoir (Regression Method 2000)

Atmospheric phosphorus inputs were measured from Wetfall/Dryfall sampling. The average concentration and average daily loadings for the wetfall and dryfall are summarized in Table 2-2. A test for outliers conducted on the results indicated that two loadings were outliers ( $>2.5$  sd from the mean), so they were removed from further analysis. The Seasonal Loadings for wetfall and dryfall were tallied to determine an annual phosphorus loading from atmospheric sources (Table 2-3).

**Table 2-2. Results of the Wetfall – Dryfall Phosphorus Monitoring (2005)**

Parameter	Mean	SD	n
Wetfall Concentration (mg/L)	0.02	0.029	20
Wetfall Loading (mg/m <sup>2</sup> /day)	0.41	0.483	20
Dryfall Concentration (mg/L)	0.36	0.37	20
Dryfall Loading (mg/m <sup>2</sup> /L)	0.27	0.27	20

Outliers: Wetfall P Loadings March 4=2.57 mg/m<sup>2</sup>/day; Dry Loadings Nov/28 = 5.29 mg/m<sup>2</sup>/day

**Table 2-3. Seasonal Atmospheric Total Phosphorus Inputs to Swift Creek Reservoir (2005).**

	Wetfall Total			Dryfall Total		
	Phosphorus Load	Rainfall		Phosphorus Load	Dryfall Period	
Season	(lbs)	(inches)	n	(lbs)	(Days)	n
Winter	30	6.19	6	15	87	6
Spring	43	5.30	6	23	49	4
Summer	26	5.77	3	31	31	1
Autumn	14	11.22	6	6	54	6
<b>Annual</b>	<b>113</b>	<b>28.48</b>	<b>21</b>	<b>74</b>	<b>221</b>	<b>17</b>

Note: Some samples were excluded from loading calculations

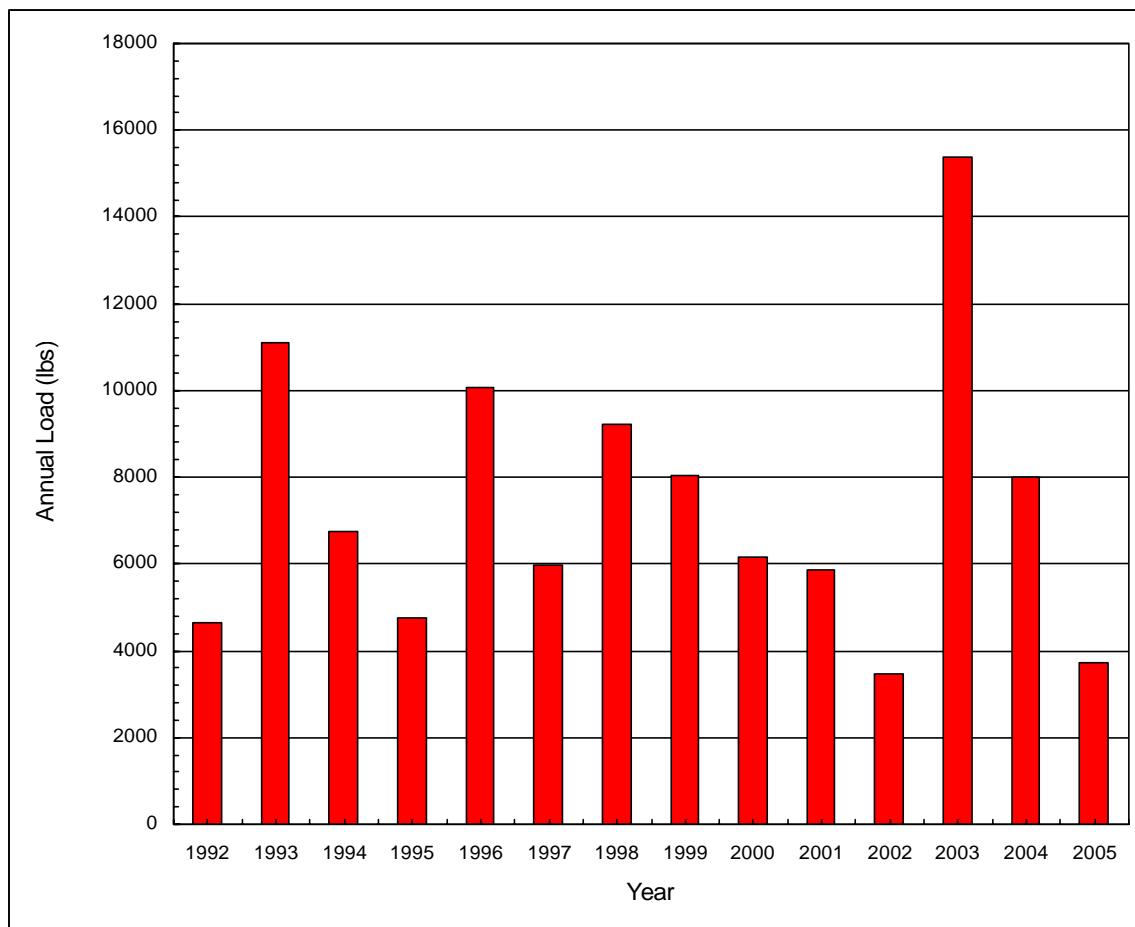
Rainfall and dry fall days are less than actual annual totals

Total reservoir load was then determined by adding tributary and atmospheric inputs (Table 2-4). The procedure described above yielded a yearly total phosphorus load of 3,715 pounds. Annual phosphorus loads for 1992 through 2005 are given in Figure 2-2 and provided in Table 2-5. The 2005 estimate of phosphorus loadings is the second lowest estimate since 1992, and is nearly 50% lower than the long-term median. This annual loading reflects the lower than average rainfall in 2005.

The weir at Chimney House Place was out of commission for a significant portion of the year, and thus under reports loadings from that watershed. The loadings for Little Tomahawk, as a percentage of the total loadings, were three times greater in 2005 than 2004.

**Table 2-4. Annual 2005 sub-basin phosphorus loads for Swift Creek Reservoir watershed as determined by the Regression Method (Leitch, 1998).**

	Station	Raw Total Phosphorus Load	Scaled Total Phosphorus Load	% Contribution
Tributary	Number	(Pounds)	(Pounds)	
Dry Creek	1	193	251	6.8
West Branch	2	183	183	4.9
Horsepen	3-I	132	156	4.2
Blackman	3-II	143	163	4.4
Otterdale	4	181	233	6.3
Swift Creek	5	1,015	1,104	29.7
Tomahawk	6	235	332	8.9
Little Tomahawk	7	412	572	15.4
Ashbrook	8	149	161	4.3
Chimney House Place (Brandermill)	13	0.18	9	0.2
Chestnut Bluff Terrace (Woodlake)	14	3.20	36	1.0
Swift Creek Wetland	-	244	265	7.1
<b>Watershed Subtotal</b>		<b>2,890</b>	<b>3465</b>	<b>93.3</b>
Atmospheric Inputs	Wetfall/Dryfall	249	249	6.7
<b>Total Watershed Load 2005:</b>		<b>3,140</b>	<b>3,715</b>	<b>100.0</b>



**Figure 2-2. Annual Phosphorus Loadings to Swift Creek Reservoir.**  
1992 & 1993 Data From Smock, 1994 – 1995 Values From OWML, 1996 Value From Hoehn Et Al., 1997 Value From SCWTP. The 1998 – 2004 Values Are Derived From The Regression Method Detailed By Lietch (1998).

**Table 2-5. Summary of Annual Phosphorus Loadings**

<b>Year</b>	<b>Annual Estimated Phosphorus Loading (pounds)</b>
1992	4,653
1993	11,100
1994	6,755
1995	4,750
1996	10,060
1997	5,976
1998	9,221
1999	8,048
2000	6,168
2001	5,859
2002	3,477
2003	15,376
2004	8,019
2005	3,715

# **Chapter 3: Hydrology & Water Budget**

## **HYDROLOGIC CHARACTERISTICS AND WATER BUDGET**

---

Total hydrologic inputs and outputs were characterized to determine the 2005 water budget for Swift Creek Reservoir (Table 3-1). A detailed description of water budget procedures can be found in the 1998 Swift Creek Reservoir Survey Report (SCWTP, 2000). The 2005 water budget for Swift Creek Reservoir was determined from the following simplified water budget equation used in previous USGS reports (Skrobialowski, 1998):

$$\text{Inflows} - \text{Outflows} = \text{Change in Storage} + \text{Residual}$$

Where:

$$\text{Inflows} = \text{Surface water inflows} + \text{total precipitation volume}$$

$$\text{Outflows} = \text{Evaporation} + \text{withdrawals} + \text{overflow} + \text{seepage}$$

$$\text{Change in Storage} = \text{Measured change in reservoir storage during the year}$$

$$\begin{aligned}\text{Residual} = & \text{ the sum of errors associated with assumed, estimated, and measured} \\ & \text{hydrologic characteristics} + \text{unaccounted for variables (i.e. groundwater flux} \\ & \text{and transpiration).}\end{aligned}$$

### ***Hydrologic Inflows***

Gauged inflow sites were categorized as main tributaries and residential catchments (Table 3-2). There are nine tributaries that drain mostly undeveloped or developing land in the watershed and two residential catchments that drain mostly developed land adjacent to the reservoir (Figure 3-1). Annual tributary inflows were 984 Mft<sup>3</sup>. Drainage from a large wetland adjacent to the Swift Creek monitoring station was estimated from flow transducers installed in a culvert pipe resulted in an annual discharge of 85.43 Mft<sup>3</sup>. Annual hydrographs (Figures 3-2a through 3-2d) and mean daily discharge values and summary statistics are presented for each site in Tables 3-3a through 3-3k. Discharges from ungaged direct runoff areas adjacent to the reservoir were estimated as in previous USGS reports, except Areas 1 and 2, and totaled 207 Mft<sup>3</sup> (Skrobialowski, 1998; Table 3-4). Direct Runoff Area 1 was calculated based on annual runoff from the Brandermill residential catchment and Direct Runoff Area 2 from the Woodlake residential catchment.

The mean precipitation for 2005 was calculated from an average of three tipping bucket rain gauges within the watershed as 35.36 inches (Table 3-5). During July and August, data from a NOAA weather station in Winterpock was used due to equipment failure at the tipping buckets in the watershed. The total direct precipitation on to the surface of the reservoir was about 208.7 Mft<sup>3</sup> (Table 3-5).

### ***Hydrologic Outputs***

The total annual discharge over the dam in 2005 was 1,598 Mft<sup>3</sup> (Table 3-1). Leakage under the dam was estimated at 0.5 Mft<sup>3</sup> because direct gauging was not possible due to continual flow over the spillway (Table 3-1). The annual overflow hydrograph (Figure 3-2c) and mean daily discharge values and summary statistics for overflow and leakage are presented in Tables 3-6a through 3-6b.

The total volume of water withdrawn for the public water supply by Addison-Evans Water Production & Laboratory Facility plant was 445 Mft<sup>3</sup> (Table 3-1). Brandermill Country Club withdrew 2.3 Mft<sup>3</sup> (Table 3-1) for golf course irrigation in 2005. Both of these volumes were within historical norms.

Evaporation from the reservoir estimated from evaporation pan data was 37.4 inches for 2005 which represented approximately 155 Mft<sup>3</sup> (Table 3-7). The evaporation rates were very high in March which was a record dry month, and low in June.

### ***Change in Reservoir Storage***

The USGS developed elevation-storage rating derived from the 1995 reservoir bathymetric survey was used to determine the annual change of storage capacity of Swift Creek Reservoir. Storage was calculated as the difference between the volume of water in the reservoir on January 1, 2005 and December 31, 2005. The reservoir was at the same elevation at the start of the year and the end, so there was no net change over the year in storage.

### ***The Residual and Explanation of Errors***

The calculated residual was 716 Mft<sup>3</sup> which is the amount of flow over the spillway in excess of the measured inputs minus the measured outputs. The residual represents the sum of errors associated with assumed, estimated, and measured hydrologic characteristics, as well as unaccounted for variables. A detailed explanation of errors associated with measurements and estimations regarding the calculation of water budgets are presented in the 1997 USGS report of hydrologic characteristics (Skrabalowski, 1998).

**Table 3-1. 2005 Water Budget for Swift Creek Reservoir**

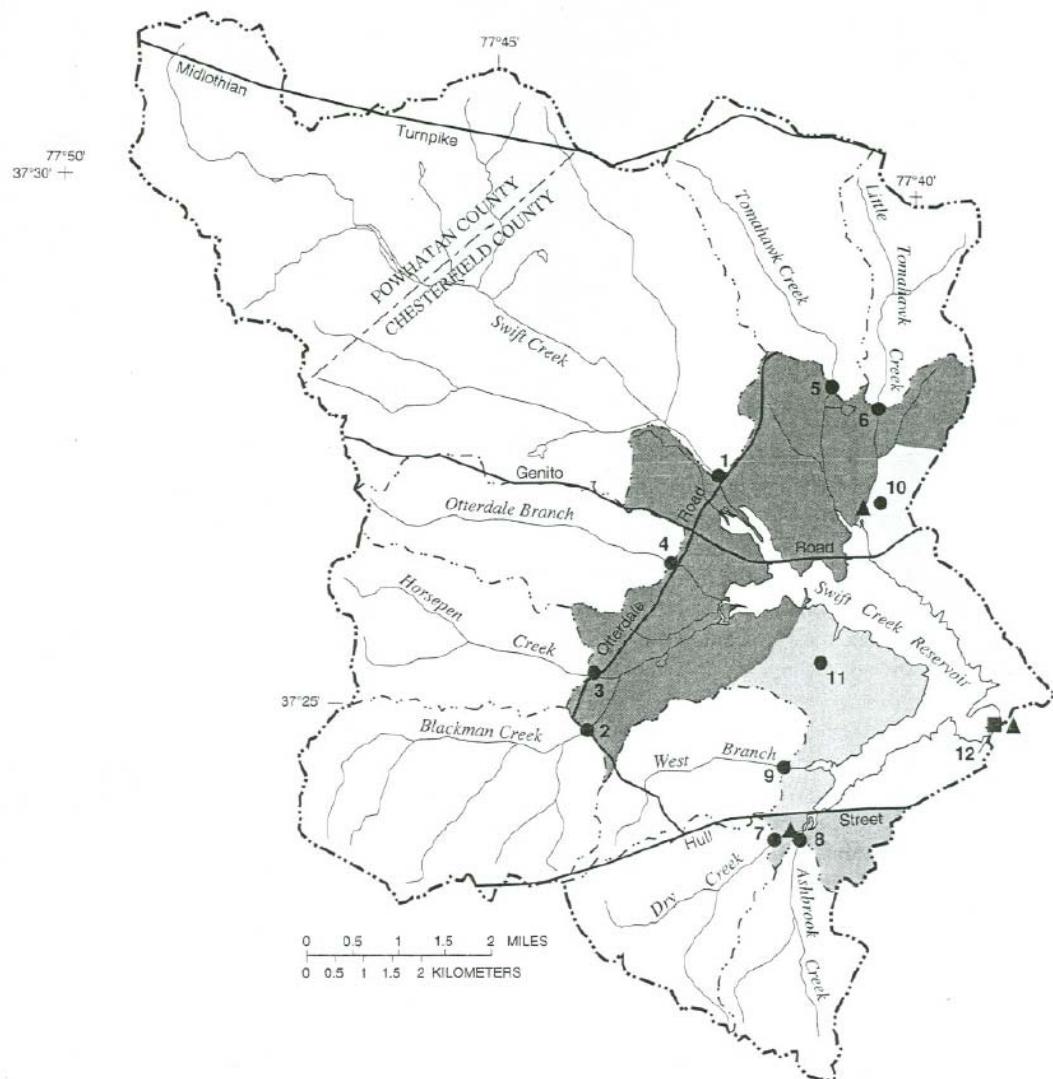
<b>Inputs</b>	<b>Mft<sup>3</sup></b>	<b>Source</b>
Monitored Tributaries	984	Stream Gauges (Table 3-2 & 3-3)
Direct Runoff Areas	207	Calculated as per USGS (Table 3-4)
Swift Creek Wetland Discharge	85	Based on velocity and stage measurements (Table 3-3i)
Precipitation	209	Scaled using mean rainfall and lake surface area (Table 3-5)
<b>Total</b>	<b>1,485</b>	
<b>Outputs</b>	<b>Mft<sup>3</sup></b>	
Evaporation	155	Calculated on monthly basis using pan data and stage/s.a. curve from OWML
Plant Withdrawals	445	Determined from operator's log
Golf Course Irrigation	2	Acquired from Brandermill Country Club
Overflow	1,598	Determined from USGS rating tables and daily average reservoir elevations from automated gage.
Leakage	1	Determined from gauging below dam
<b>Total</b>	<b>2,201</b>	
Change in Storage	0	Calculated using intake gauge and USGS storage data regressed
Residual	<b>716</b>	Unaccounted for flow over spillway

All inputs and outputs rounded to nearest whole number

**Table 3-2. Drainage Area, Discharge, and Runoff Data for Tributaries and Residential Catchments**

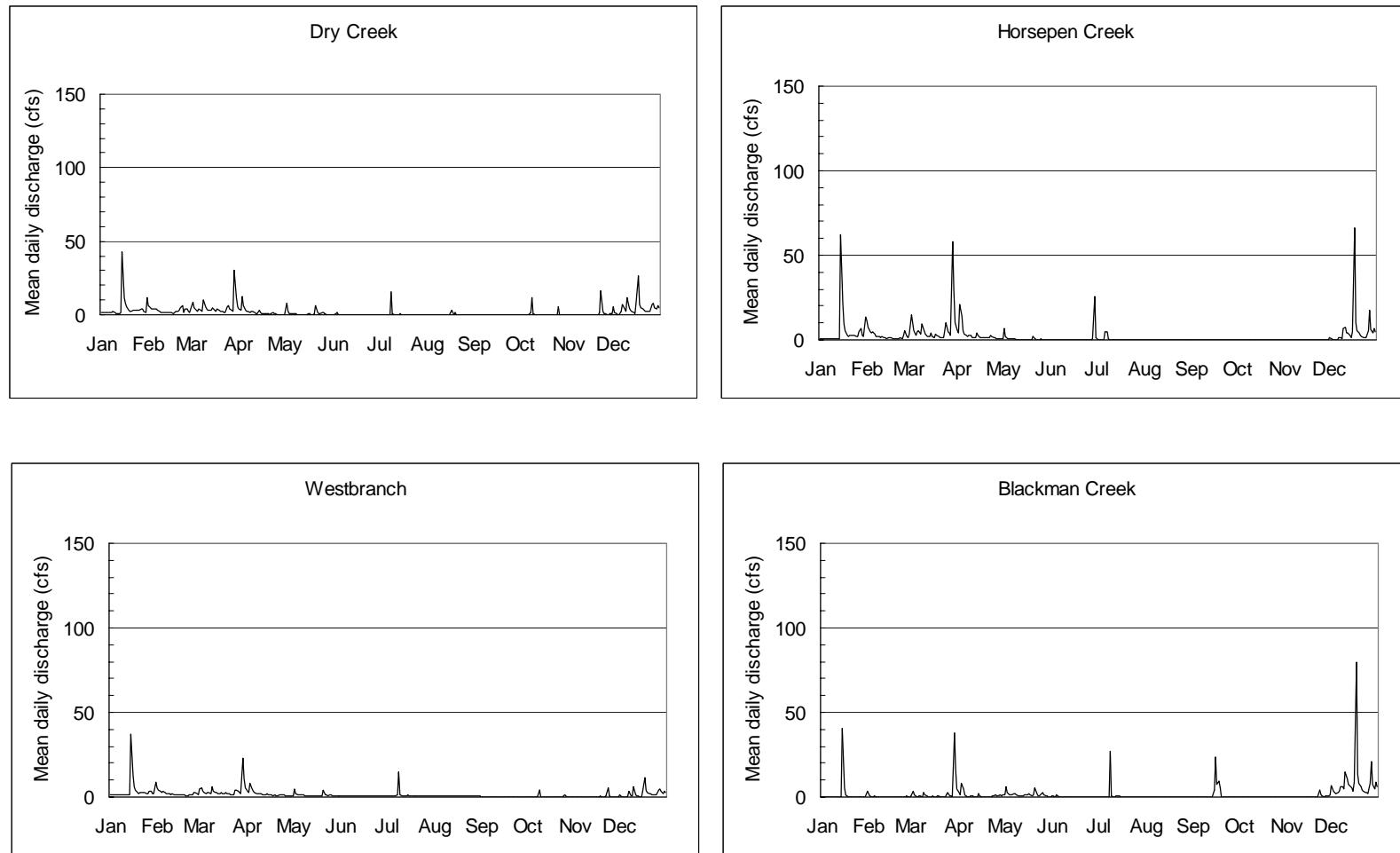
	Station Number	Drainage Area	Average Daily Mean Discharge	Max Daily Mean Discharge	Min Daily Mean Discharge	Gauged Annual Flow	Annual Runoff
<b>Tributary</b>		(sq. miles)	(ft <sup>3</sup> /s)	(ft <sup>3</sup> /s)	(ft <sup>3</sup> /s)	(Mft <sup>3</sup> )	Mft <sup>3</sup> /mi <sup>2</sup> )
Dry Creek	1	2.96	1.87	42.43	0	59.04	19.9
Westbranch	2	2.75	1.45	37.02	0	45.75	16.6
Horsepen	3-I	3.72	2.14	66.47	0	67.62	18.2
Blackman	3-II	5.80	1.65	79.77	0	52.07	9.0
Otterdale	4	3.59	2.57	37.77	0.9	81.13	22.6
Swift Creek	5	21.40	11.19	117.9	0	352.78	16.5
Tomahawk	6	4.20	4.67	64.94	0	145.51	34.6
Little Tomahawk	7	2.31	3.6	48.53	0.42	131.45	49.2
Ashbrook	8	2.37	1.49	25	0	47.02	19.8
<b>Total</b>		<b>49.10</b>				<b>982.37</b>	
<b>Residential Catchments:</b>							
Brandermill	13	0.05	0	0.2	0	0.08	1.6
Woodlake	14	0.19	0.06	1.06	0	1.89	9.9
<b>Swift Creek Dam</b>	Spillway	64.40	50.68	725	0	<b>1598</b>	24.8

**Figure 3-1 Sub-basins and Data Collection Sites in the Swift Creek Drainage Basin  
(From Skrowbialowski, 1998)**

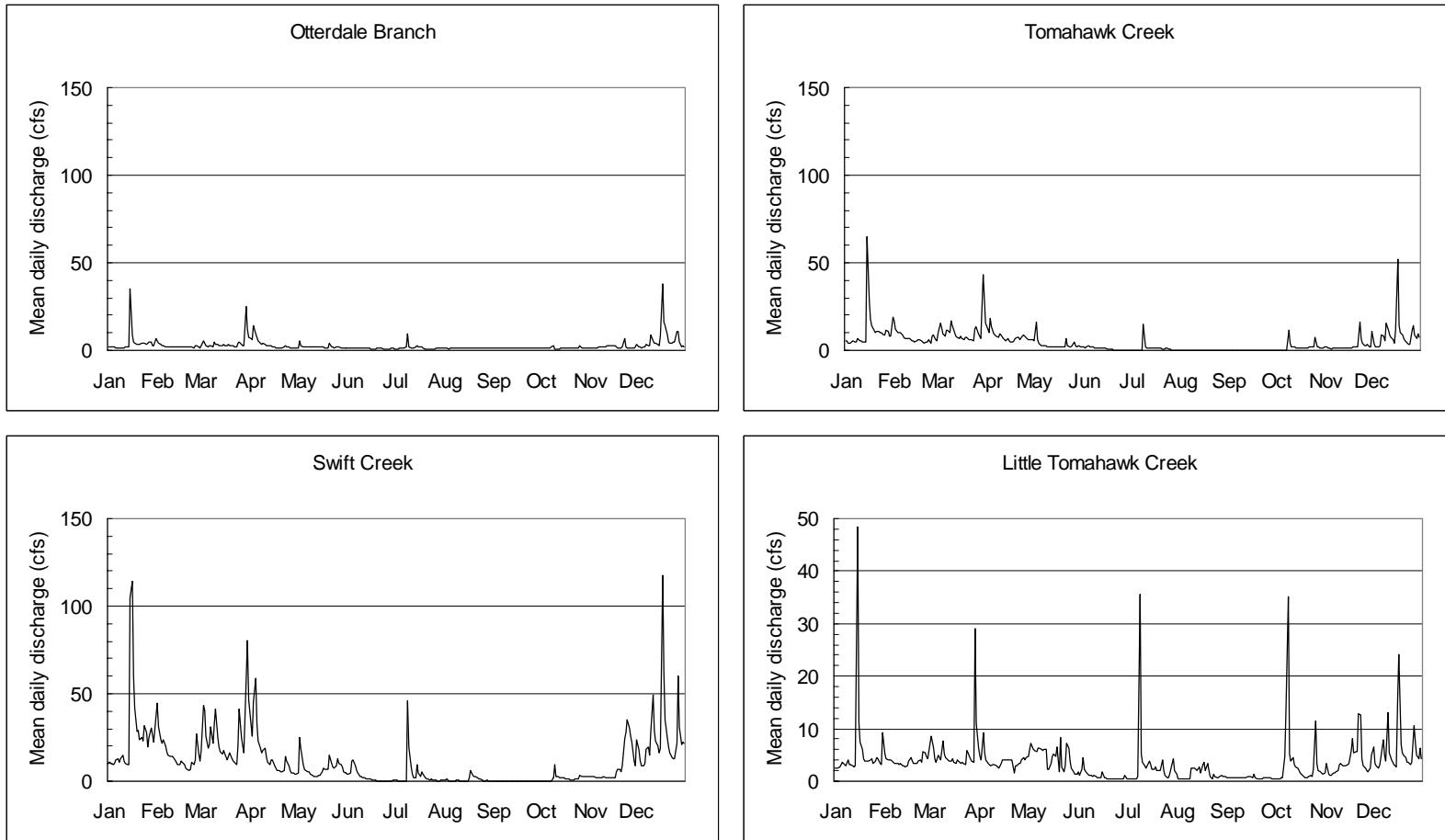


Base from U.S. Geological Survey  
1:100,000 Digital Line Graph

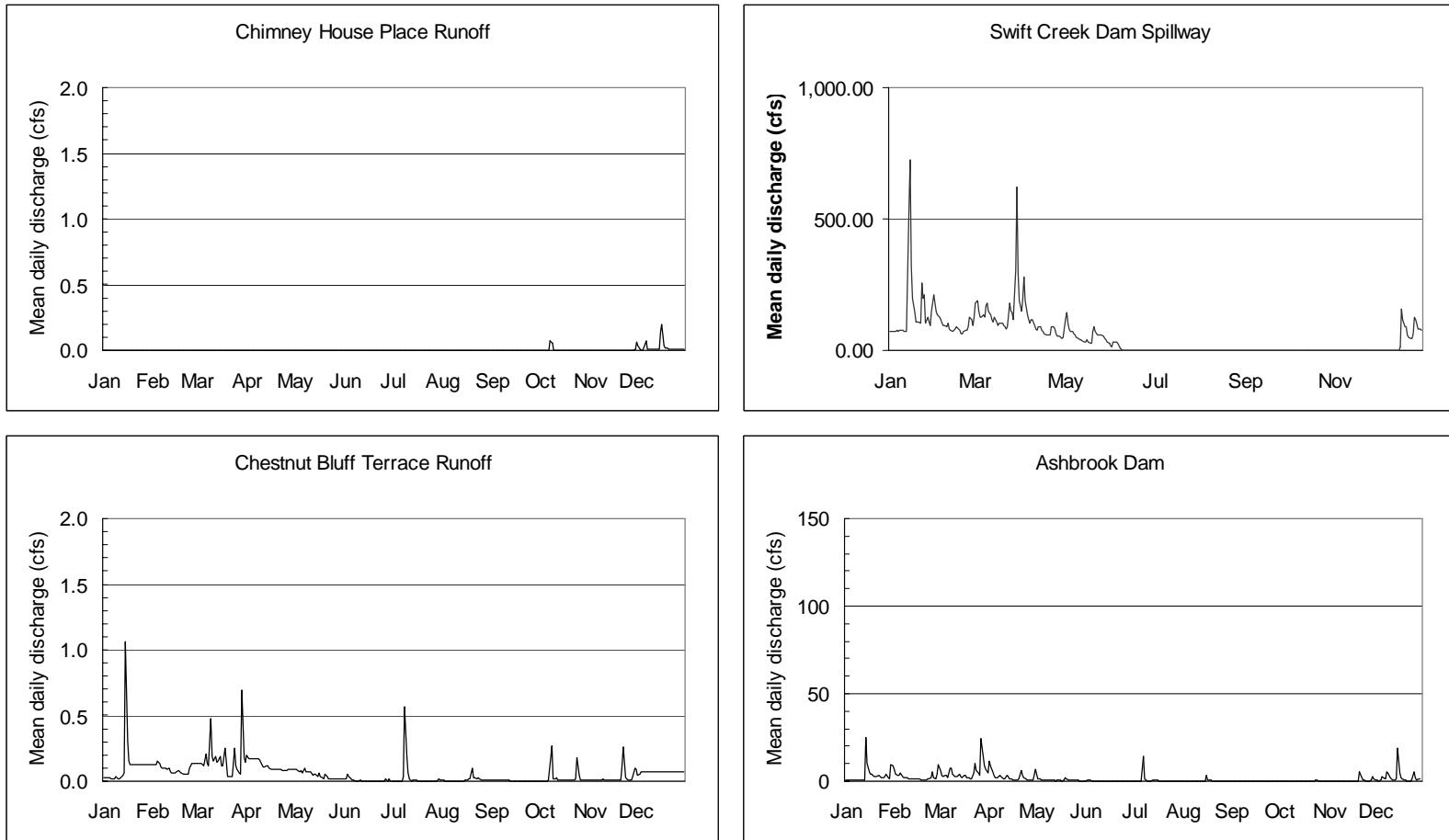
EXPLANATION	
[White Box]	DIRECT RUNOFF AREA 1
[Light Gray Box]	DIRECT RUNOFF AREA 2
[Medium Gray Box]	DIRECT RUNOFF AREA 3
[Dark Gray Box]	DIRECT RUNOFF AREA 4
—	DRAINAGE-BASIN BOUNDARY
- - -	SUBBASIN OF SWIFT CREEK BASIN
▲	RAIN GAGE
●	INFLOW SITE AND NUMBER (Table1)
■	OUTFLOW SITE AND NUMBER (Table1)



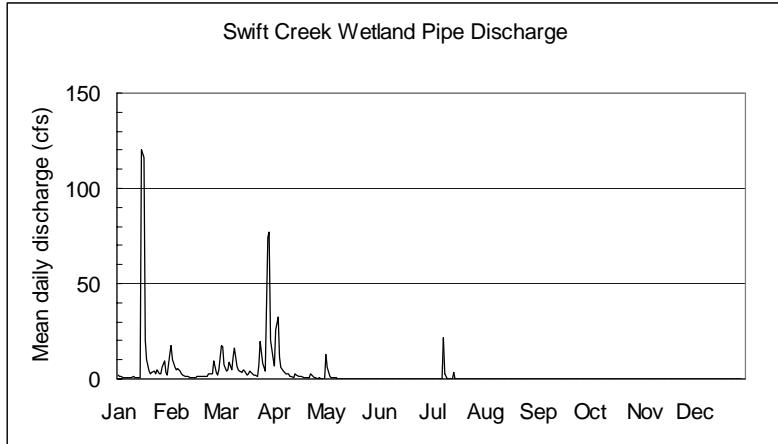
**Figure 3-2a. 2005 Discharge Hydrographs for the Western Tributaries of Swift Creek Reservoir Watershed.**



**Figure 3-2b. 2005 Discharge Hydrographs for the Northern Tributaries of Swift Creek Reservoir Watershed.**



**Figure 3-2c. 2005 Discharge Hydrographs for the Direct Runoff Sites and Impounded Waters of Swift Creek Reservoir Watershed.**



**Figure 3-2d. 2005 Discharge Hydrographs for the Direct Runoff Sites and Impounded Waters of Swift Creek Reservoir Watershed.**

Table 3-3a. 2005 daily mean discharges (cubic feet/second) for sites within the Swift Creek Reservoir Watershed. Bold values indicate estimated flow.

**Dry Creek**

<u>Day</u>	<u>January</u>	<u>February</u>	<u>March</u>	<u>April</u>	<u>May</u>	<u>June</u>	<u>July</u>	<u>August</u>	<u>September</u>	<u>October</u>	<u>November</u>	<u>December</u>
1	1.55	6.40	6.36	3.77	0.26	0.23	0.07	0.02	0.08	0.00	0.07	5.55
2	1.46	4.86	8.20	3.18	8.14	0.19	0.07	0.02	0.02	0.00	0.05	1.33
3	1.40	3.70	4.77	12.43	2.16	0.67	0.07	0.02	0.01	0.00	0.06	0.69
4	1.35	3.57	3.21	6.11	1.12	1.55	0.07	0.02	0.16	0.00	0.06	0.34
5	1.39	4.27	2.57	3.45	0.76	0.25	0.07	0.02	0.01	0.00	0.09	0.33
6	1.41	3.51	3.60	2.53	0.62	0.18	0.07	0.02	0.00	0.00	0.10	2.51
7	1.40	2.84	3.34	1.99	1.04	0.20	0.07	0.02	0.00	0.00	0.12	7.23
8	1.24	2.12	2.49	1.83	0.70	0.18	0.22	0.02	0.00	1.41	0.14	3.54
9	2.03	1.47	9.77	2.44	0.39	0.17	15.30	0.02	0.01	11.81	0.16	2.14
10	1.35	1.39	5.26	2.36	0.26	0.15	0.64	0.18	0.00	0.39	0.19	11.74
11	1.13	1.80	3.61	1.23	0.22	0.20	0.18	0.12	0.00	0.18	0.18	4.78
12	1.01	1.61	3.41	0.91	0.21	0.18	0.16	0.02	0.00	0.19	0.19	3.06
13	1.10	1.66	3.21	0.83	0.20	0.16	0.13	0.02	0.00	0.15	0.20	2.61
14	1.31	1.69	3.12	3.25	0.28	0.15	0.20	0.02	0.00	0.12	0.22	1.64
15	42.43	1.71	4.43	1.44	0.20	0.12	0.82	0.02	0.00	0.10	0.21	0.65
16	11.46	1.66	2.73	0.84	0.85	0.19	0.24	0.09	0.01	0.07	0.24	8.40
17	7.53	0.88	2.26	0.60	1.09	0.09	0.16	1.91	0.00	0.05	0.28	26.79
18	5.07	1.71	4.18	0.55	0.24	0.07	0.12	3.23	0.00	0.05	0.28	6.74
19	2.78	2.20	3.21	0.53	0.19	0.07	0.09	0.26	0.00	0.04	0.14	4.69
20	2.31	2.63	2.29	0.40	0.60	0.07	0.07	1.41	0.00	0.05	0.09	3.89
21	2.62	3.20	2.02	0.34	6.26	0.07	0.07	0.23	0.00	0.05	0.07	3.24
22	2.93	4.48	1.67	0.73	1.68	0.07	0.07	0.17	0.00	0.07	1.39	2.71
23	2.89	6.60	1.42	1.25	0.78	0.07	0.07	0.17	0.00	0.10	16.14	2.34
24	3.49	1.83	5.71	0.88	0.47	0.07	0.07	0.17	0.00	0.09	2.48	2.14
25	2.98	4.08	6.47	0.48	1.38	0.07	0.07	0.17	0.00	0.19	1.00	2.04
26	2.75	3.89	3.62	0.28	1.39	0.07	0.07	0.17	0.00	5.75	0.42	7.24
27	3.68	2.18	2.89	0.23	0.68	0.09	0.07	0.17	0.00	0.27	0.27	7.98
28	3.69	1.66	2.27	0.22	0.32	0.08	0.07	0.18	0.00	0.16	0.23	4.58
29	1.96		30.62	0.19	0.25	0.07	0.07	0.17	0.00	0.10	0.43	3.74
30	1.94		11.58	0.25	0.22	0.07	0.14	0.17	0.00	0.07	0.93	6.05
31	11.63		5.38		0.20		0.02	0.15		0.07		4.42
<b>Mean</b>	4.23	2.84	5.02	1.85	1.07	0.19	0.63	0.30	0.01	0.69	0.88	4.68
<b>Max</b>	42.43	6.60	30.62	12.43	8.14	1.55	15.30	3.23	0.16	11.81	16.14	26.79
<b>Min</b>	1.01	0.88	1.42	0.19	0.19	0.07	0.02	0.02	0.00	0.00	0.05	0.33

Table 3-3b. 2005 daily mean discharges (cubic feet/second) for sites within the Swift Creek Reservoir Watershed. Bold values indicate estimated flow.

**Westbranch**

<u>Day</u>	<u>January</u>	<u>February</u>	<u>March</u>	<u>April</u>	<u>May</u>	<u>June</u>	<u>July</u>	<u>August</u>	<u>September</u>	<u>October</u>	<u>November</u>	<u>December</u>
1	1.35	5.13	4.53	3.45	0.81	0.45	0.45	0.45	0.09	0.00	0.00	1.57
2	1.32	4.03	5.32	2.71	4.59	0.45	0.45	0.45	0.00	0.00	0.00	0.31
3	1.32	3.19	3.61	8.31	2.29	0.51	0.45	0.45	0.00	0.00	0.00	0.20
4	1.27	3.02	2.63	4.80	1.59	0.59	0.45	0.45	0.00	0.00	0.00	0.09
5	1.28	3.12	2.12	3.07	1.30	0.47	0.45	0.45	0.00	0.00	0.00	0.13
6	1.37	2.63	2.70	2.50	1.16	0.45	0.45	0.45	0.00	0.00	0.00	0.70
7	1.35	2.26	2.50	1.92	1.21	0.45	0.45	0.45	0.00	0.00	0.00	3.06
8	1.35	1.94	2.12	1.75	1.02	0.45	1.55	0.45	0.00	0.00	0.05	0.85
9	1.57	1.71	5.95	2.07	0.91	0.45	14.74	0.45	0.00	4.10	0.05	0.41
10	1.49	1.64	3.54	2.14	0.80	0.45	1.17	0.47	0.00	0.28	0.08	5.83
11	1.39	1.79	2.67	1.63	0.73	0.45	0.94	0.45	0.00	0.20	0.10	1.41
12	1.36	1.43	2.39	1.46	0.66	0.45	0.76	0.45	0.00	0.26	0.04	0.72
13	1.30	1.27	2.13	1.37	0.66	0.45	0.60	0.45	0.00	0.18	0.04	0.40
14	1.37	1.27	2.11	2.07	0.57	0.45	0.95	0.45	0.00	0.17	0.05	0.21
15	37.02	1.43	2.64	1.65	0.45	0.45	1.02	0.45	0.00	0.18	0.05	0.05
16	13.09	1.43	1.98	1.46	0.55	0.45	0.91	0.50	0.00	0.26	0.06	3.63
17	6.16	1.36	1.73	1.17	0.63	0.45	0.82	0.46	0.00	0.24	0.20	11.65
18	3.98	1.26	2.39	1.00	0.54	0.45	0.71	0.54	0.00	0.17	0.34	4.00
19	2.80	1.14	2.07	1.24	0.45	0.45	0.58	0.45	0.00	0.17	0.17	2.88
20	2.34	1.01	1.74	0.99	0.47	0.45	0.46	0.58	0.00	0.03	0.10	2.24
21	2.42	0.99	1.66	0.94	3.95	0.45	0.45	0.45	0.00	0.19	0.08	1.83
22	2.57	1.12	1.54	1.19	1.53	0.45	0.45	0.45	0.00	0.21	0.61	1.57
23	2.55	1.39	1.36	1.55	1.14	0.45	0.45	0.45	0.00	0.27	5.17	1.40
24	2.77	1.23	3.91	1.50	1.01	0.45	0.45	0.45	0.00	0.22	0.43	1.32
25	2.08	2.77	4.37	1.23	1.06	0.45	0.45	0.45	0.00	0.36	0.27	1.28
26	2.31	2.60	3.14	0.98	1.06	0.45	0.45	0.45	0.00	1.16	0.15	4.11
27	3.20	1.92	2.59	0.89	0.97	0.54	0.45	0.45	0.00	0.04	0.09	4.81
28	3.15	1.64	2.20	0.88	0.79	0.45	0.45	0.45	0.00	0.00	0.09	3.08
29	2.28		23.08	0.77	0.69	0.45	0.45	0.45	0.00	0.00	0.23	2.35
30	2.02		10.92	0.77	0.53	0.45	0.45	0.45	0.00	0.00	0.32	3.26
31	8.58		5.27		0.45		0.45	0.39		0.00		2.48
<b>Mean</b>	3.82	1.99	3.77	1.91	1.11	0.46	1.07	0.45	0.00	0.28	0.29	2.19
<b>Max</b>	37.02	5.13	23.08	8.31	4.59	0.59	14.74	0.58	0.09	4.10	5.17	11.65
<b>Min</b>	1.27	0.99	1.36	0.77	0.45	0.45	0.45	0.39	0.00	0.00	0.00	0.05

Table 3-3c. 2005 daily mean discharges (cubic feet/second) for sites within the Swift Creek Reservoir Watershed. Bold values indicate estimated flow.

Horsepen Creek

Table 3-3d. 2005 daily mean discharges (cubic feet/second) for sites within the Swift Creek Reservoir Watershed. Bold values indicate estimated flow.

Blackman Creek

Table 3-3e. 2005 daily mean discharges (cubic feet/second) for sites within the Swift Creek Reservoir Watershed. Bold values indicate estimated flow.

**Otterdale Branch**

<u>Day</u>	<u>January</u>	<u>February</u>	<u>March</u>	<u>April</u>	<u>May</u>	<u>June</u>	<u>July</u>	<u>August</u>	<u>September</u>	<u>October</u>	<u>November</u>	<u>December</u>
1	2.36	5.37	2.82	6.77	1.52	1.33	1.00	1.02	1.11	1.37	1.53	3.41
2	2.19	3.78	5.27	5.83	5.30	1.26	0.98	1.04	1.12	1.32	1.33	2.03
3	2.25	3.24	3.76	14.36	2.63	1.40	0.99	1.02	1.12	1.28	1.39	1.73
4	2.07	2.62	2.69	9.80	1.98	1.68	1.02	1.01	1.17	1.24	1.41	1.58
5	1.71	2.73	2.18	7.48	1.71	1.45	1.03	1.02	1.18	1.22	1.52	1.69
6	1.37	2.36	2.87	5.55	1.86	1.32	1.06	1.14	1.21	1.23	1.62	2.27
7	1.31	2.08	2.98	4.12	2.33	1.23	1.08	1.24	1.26	1.18	1.71	3.69
8	1.53	2.01	2.31	3.67	2.19	1.15	1.69	1.18	1.30	1.70	1.72	2.94
9	1.63	2.27	4.45	3.83	2.00	1.08	9.42	1.20	1.33	2.72	1.80	2.38
10	1.48	2.16	3.65	3.59	1.86	1.14	1.75	1.22	1.31	0.90	1.97	8.46
11	1.67	2.24	3.18	3.04	1.81	1.16	1.44	1.12	1.30	0.99	2.06	5.66
12	1.75	1.98	2.96	2.80	1.74	1.12	1.36	1.12	1.25	0.90	2.38	4.09
13	1.84	1.88	2.73	2.68	1.74	1.10	1.35	1.20	1.15	0.94	2.40	3.73
14	1.77	1.77	2.68	2.91	1.71	1.09	2.23	1.15	1.05	1.05	2.55	3.26
15	35.38	1.85	3.34	2.07	1.70	1.01	2.70	1.17	1.04	1.02	2.74	2.67
16	8.63	2.11	2.74	1.73	1.75	0.97	2.08	1.26	1.06	1.05	2.55	8.19
17	4.92	2.16	2.47	1.64	1.75	1.00	1.91	1.39	1.11	1.11	2.97	37.66
18	3.83	2.01	3.08	1.61	1.52	1.00	1.87	1.44	1.04	1.16	2.20	16.30
19	3.42	1.87	2.90	1.62	1.47	1.01	1.44	1.28	1.05	1.21	1.54	13.97
20	3.41	1.78	2.48	1.62	1.60	1.02	0.99	1.49	1.07	1.23	1.51	8.79
21	3.65	1.76	2.39	1.68	4.00	1.08	0.98	1.36	1.11	1.33	1.56	4.98
22	3.98	1.92	2.22	2.16	2.21	1.06	0.97	1.36	1.15	1.31	2.19	4.29
23	3.88	2.22	2.13	2.55	1.83	1.02	0.96	1.25	1.21	1.39	6.95	4.08
24	4.09	1.68	4.29	2.08	1.66	1.00	0.95	1.11	1.28	1.44	2.33	4.95
25	3.45	2.39	4.92	1.72	1.86	0.97	1.01	1.04	1.34	1.61	1.66	4.90
26	3.77	2.75	3.31	1.57	2.08	0.96	1.01	1.02	1.35	2.49	1.40	10.48
27	4.69	1.89	2.96	1.48	1.78	0.98	1.33	1.07	1.33	1.47	1.28	10.59
28	4.42	1.65	2.66	1.53	1.51	0.99	1.43	1.06	1.32	1.36	1.25	4.68
29	2.85		24.73	1.41	1.43	1.12	1.32	1.08	1.40	1.40	1.39	2.20
30	2.66		12.04	1.46	1.37	1.09	1.35	1.10	1.40	1.49	1.81	2.97
31	7.06		7.48		1.32		1.10	1.09		1.60		2.21
<b>Mean</b>	4.16	2.30	4.22	3.48	1.98	1.13	1.61	1.17	1.20	1.35	2.02	6.16
<b>Max</b>	35.38	5.37	24.73	14.36	5.30	1.68	9.42	1.49	1.40	2.72	6.95	37.66
<b>Min</b>	1.31	1.65	2.13	1.41	1.32	0.96	0.95	1.01	1.04	0.90	1.25	1.58

Table 3-3f. 2005 daily mean discharges (cubic feet/second) for sites within the Swift Creek Reservoir Watershed. Bold values indicate estimated flow.

**Swift Creek**

Day	January	February	March	April	May	June	July	August	September	October	November	December
1	10.72	44.33	17.72	32.20	4.59	4.32	0.51	0.76	0.14	0.00	2.43	23.92
2	10.59	31.03	43.24	25.55	24.78	3.88	1.01	0.78	0.11	0.00	2.45	18.18
3	10.02	23.58	40.57	45.54	19.07	5.03	0.10	1.01	0.10	0.00	2.44	12.47
4	9.75	21.62	25.66	58.87	9.23	11.31	0.15	0.31	0.10	0.00	2.42	9.06
5	9.92	23.48	18.74	33.26	6.63	12.03	0.10	0.19	0.10	0.00	2.33	8.84
6	11.90	20.60	21.19	23.16	5.95	8.91	0.03	0.11	0.08	0.00	2.25	10.38
7	12.78	16.86	31.16	18.98	5.41	6.26	0.02	0.10	0.07	0.00	2.22	18.43
8	10.87	15.14	21.80	16.16	5.15	4.47	0.04	0.14	0.05	0.00	2.16	19.49
9	12.98	14.29	32.56	17.80	4.35	<b>2.93</b>	45.77	0.59	0.03	1.78	2.11	14.83
10	15.08	13.97	40.89	18.96	3.69	<b>2.54</b>	19.51	0.80	0.00	9.15	2.38	28.43
11	11.61	14.28	24.91	13.39	2.80	<b>2.20</b>	8.00	0.10	0.00	2.92	2.17	49.04
12	10.20	12.27	19.57	10.91	2.55	<b>1.90</b>	3.96	0.06	0.00	2.40	2.20	28.73
13	9.46	10.51	17.18	9.26	2.74	<b>1.66</b>	2.05	0.07	0.00	2.25	2.17	23.16
14	9.27	9.69	15.23	12.49	3.27	<b>1.47</b>	2.21	0.03	0.01	2.23	2.12	20.12
15	104.65	9.54	17.73	11.87	3.58	<b>1.32</b>	9.23	0.04	0.00	2.10	2.06	15.91
16	114.51	11.80	15.83	8.88	5.16	<b>1.15</b>	4.57	0.04	0.00	1.93	2.04	19.12
17	60.16	10.59	12.36	7.12	7.38	<b>0.96</b>	2.86	1.70	0.00	1.48	2.15	117.90
18	41.73	9.15	13.89	6.25	6.78	<b>0.76</b>	5.08	6.01	0.00	1.17	5.45	62.21
19	28.66	7.62	16.36	5.90	6.45	<b>0.55</b>	3.76	3.35	0.00	1.07	6.72	34.85
20	29.01	6.66	12.91	5.71	6.47	<b>0.32</b>	1.91	2.88	0.00	0.94	6.63	24.47
21	23.85	6.36	11.26	5.31	15.15	<b>0.17</b>	1.48	2.55	0.00	0.87	5.46	19.88
22	25.08	7.04	10.89	6.22	10.02	0.16	1.05	1.74	0.00	0.88	8.67	16.48
23	23.24	10.53	9.13	14.02	8.27	0.31	0.92	1.42	0.00	1.16	24.64	13.75
24	31.60	9.14	20.09	11.40	7.62	0.12	1.07	1.10	0.00	1.21	27.67	12.53
25	27.96	12.00	41.11	8.71	8.76	0.11	0.77	0.82	0.00	1.23	35.01	12.69
26	19.51	26.87	24.75	6.31	12.76	0.00	0.67	0.32	0.00	3.24	30.08	21.91
27	24.67	15.59	20.48	5.02	10.46	0.01	0.69	0.22	0.00	3.04	25.75	60.37
28	30.13	11.70	16.35	4.49	9.32	0.10	0.25	0.40	0.00	2.86	22.30	30.93
29	26.36		57.78	4.12	8.27	0.04	0.22	0.25	0.00	2.70	11.59	20.81
30	22.00		80.09	3.96	5.44	0.35	0.52	0.18	0.00	2.58	8.81	22.20
31	36.93		46.74		4.65		0.69	0.14		2.51		21.85
<b>Mean</b>	26.62	15.22	25.75	15.06	7.64	2.51	3.84	0.91	0.03	1.67	8.56	26.22
<b>Max</b>	114.51	44.33	80.09	58.87	24.78	12.03	<b>45.77</b>	6.01	0.14	9.15	35.01	117.90
<b>Min</b>	9.27	6.36	9.13	3.96	2.55	0.00	0.02	0.03	0.00	0.00	2.04	8.84

Table 3-3g. 2005 daily mean discharges (cubic feet/second) for sites within the Swift Creek Reservoir Watershed. Bold values indicate estimated flow.

## **Tomahawk Creek**

Table 3-3h. 2005 daily mean discharges (cubic feet/second) for sites within the Swift Creek Reservoir Watershed. Bold values indicate estimated flow.

**Little Tomahawk Creek**

<u>Day</u>	<u>January</u>	<u>February</u>	<u>March</u>	<u>April</u>	<u>May</u>	<u>June</u>	<u>July</u>	<u>August</u>	<u>September</u>	<u>October</u>	<u>November</u>	<u>December</u>
1	2.56	5.27	7.17	4.74	<b>4.75</b>	1.78	0.55	1.42	0.68	0.54	1.51	6.62
2	2.57	4.36	8.55	4.13	<b>6.18</b>	1.20	0.53	0.56	0.66	0.49	3.40	3.47
3	2.49	3.96	6.25	9.18	<b>7.18</b>	2.35	0.42	0.44	0.60	0.49	1.28	2.88
4	2.78	3.97	4.18	5.32	<b>5.98</b>	4.58	0.42	0.44	0.60	0.56	1.23	2.58
5	3.07	4.06	3.64	3.97	<b>5.78</b>	2.22	0.42	0.42	0.61	0.69	1.24	3.11
6	3.54	3.68	4.85	3.47	<b>5.61</b>	1.60	0.42	0.42	0.57	0.76	1.48	4.77
7	3.21	3.46	4.55	3.18	<b>6.38</b>	1.37	0.42	0.45	0.58	4.70	1.63	7.79
8	2.96	3.30	4.14	2.97	<b>6.38</b>	1.22	0.88	0.42	0.60	13.73	1.87	5.03
9	3.97	3.35	7.62	3.06	<b>5.98</b>	1.08	35.70	0.42	0.61	35.06	2.01	3.75
10	3.21	3.23	5.26	3.10	<b>5.78</b>	0.99	5.28	2.49	0.61	5.26	3.26	13.13
11	3.12	3.38	4.42	2.87	<b>5.98</b>	1.07	3.53	2.45	0.74	3.81	3.29	5.43
12	3.00	3.00	4.16	2.66	<b>5.98</b>	0.95	2.83	2.42	0.67	4.49	2.85	4.11
13	2.78	2.82	3.90	2.52	<b>2.36</b>	0.79	2.47	2.36	0.74	3.25	2.96	3.66
14	2.95	2.74	3.84	3.30	<b>2.24</b>	0.77	2.92	2.14	0.88	2.64	2.98	3.23
15	48.53	3.03	4.23	<b>4.15</b>	<b>3.48</b>	0.78	3.81	2.79	0.90	2.53	3.26	2.79
16	11.19	3.75	3.65	<b>4.15</b>	<b>4.75</b>	1.75	3.05	1.47	0.84	2.02	3.36	15.40
17	7.45	4.45	3.48	<b>4.15</b>	<b>5.26</b>	0.71	2.23	3.23	0.70	1.66	5.75	24.19
18	6.05	3.82	4.11	<b>4.15</b>	<b>4.75</b>	0.69	2.28	3.65	1.30	1.10	8.16	6.98
19	4.21	3.48	3.80	<b>4.15</b>	6.44	0.42	2.74	1.96	0.63	0.81	5.45	5.42
20	3.72	3.37	3.45	<b>4.15</b>	1.72	0.42	1.98	3.48	0.49	0.70	5.64	4.93
21	3.80	3.39	3.53	<b>4.15</b>	8.28	0.42	1.95	2.10	0.50	0.68	5.56	4.45
22	3.86	3.79	3.29	<b>1.65</b>	2.69	0.42	2.08	0.86	0.49	0.91	12.91	3.68
23	3.97	4.15	3.15	<b>3.04</b>	1.86	0.42	3.98	0.56	0.54	1.05	12.50	3.54
24	4.21	3.65	5.76	<b>3.04</b>	2.88	0.42	1.94	1.40	0.58	0.82	4.26	3.24
25	3.42	5.59	5.39	<b>3.33</b>	7.27	0.42	1.02	1.01	0.62	2.27	3.00	3.57
26	3.74	5.49	4.24	<b>3.33</b>	6.23	0.42	0.78	0.64	0.62	11.41	2.38	10.48
27	4.49	4.64	3.87	<b>4.06</b>	3.88	0.47	0.71	0.61	0.61	3.31	2.07	7.15
28	4.23	4.26	3.69	<b>4.40</b>	2.49	0.42	1.24	0.99	0.67	2.13	1.88	4.95
29	3.27		28.98	<b>4.06</b>	1.85	0.45	3.38	1.12	0.49	1.71	2.50	4.35
30	3.22		10.96	<b>4.58</b>	1.43	1.17	4.19	0.92	0.55	1.50	4.91	6.27
31	9.33		6.33		1.40		2.04	0.86		1.44		4.35
<b>Mean</b>	5.51	3.84	5.63	3.83	4.62	1.06	3.10	1.43	0.66	3.63	3.82	5.98
<b>Max</b>	48.53	5.59	28.98	9.18	8.28	4.58	35.70	3.65	1.30	35.06	12.91	24.19
<b>Min</b>	2.49	2.74	3.15	1.65	1.40	0.42	0.42	0.42	0.49	0.49	1.23	2.58

Table 3-3i. 2005 daily mean discharges (cubic feet/second) for sites within the Swift Creek Reservoir Watershed. Bold values indicate estimated flow.

## **Swift Creek Wetland Discharge**

Table 3-3j. 2005 daily mean discharges (cubic feet/second) for sites within the Swift Creek Reservoir Watershed. Bold values indicate estimated flow.

**Chimney House Place Direct Runoff Site (Brandermill)**

<u>Day</u>	<u>January</u>	<u>February</u>	<u>March</u>	<u>April</u>	<u>May</u>	<u>June</u>	<u>July</u>	<u>August</u>	<u>September</u>	<u>October</u>	<u>November</u>	<u>December</u>
1									0.00	0.00	0.00	0.06
2									0.00	0.00	0.00	0.04
3									0.00	0.00	0.00	0.01
4									0.00	0.00	0.00	0.00
5									0.00	0.00	0.00	0.00
6									0.00	0.00	0.00	0.04
7									0.00	0.00	0.00	0.08
8									0.00	0.07	0.00	0.01
9									0.00	0.05	0.00	0.01
10									0.00	0.00	0.00	0.01
11									0.00	0.00	0.00	0.01
	<b>Weir repaired gaging resumed</b>											
12									0.00	0.00	0.00	0.01
13									0.00	0.00	0.00	0.01
14									0.00	0.00	0.00	0.01
15									0.00	0.00	0.00	0.01
16									0.00	0.00	0.00	0.14
17									0.00	0.00	0.00	0.20
18									0.00	0.00	0.00	0.03
19									0.00	0.00	0.00	0.02
20									0.00	0.00	0.00	0.02
21									0.00	0.00	0.00	0.01
22									0.00	0.00	0.00	0.01
23									0.00	0.00	0.00	0.01
24									0.00	0.00	0.00	0.01
25									0.00	0.00	0.00	0.01
26									0.00	0.00	0.00	0.01
27									0.00	0.00	0.00	0.01
28									0.00	0.00	0.00	0.01
29									0.00	0.00	0.00	0.01
30									0.00	0.00	0.01	0.01
31									0.00	0.00	0.00	0.01
<b>Mean</b>	N/A	N/A	N/A	N/A	N/A	N/A	N/A	0.00	0.00	0.00	0.00	0.03
<b>Max</b>	N/A	N/A	N/A	N/A	N/A	N/A	N/A	0.00	0.00	0.07	0.01	0.20
<b>Min</b>	N/A	N/A	N/A	N/A	N/A	N/A	N/A	0.00	0.00	0.00	0.00	

Table 3-3k. 2005 daily mean discharges (cubic feet/second) for sites within the Swift Creek Reservoir Watershed. Bold values indicate estimated flow.

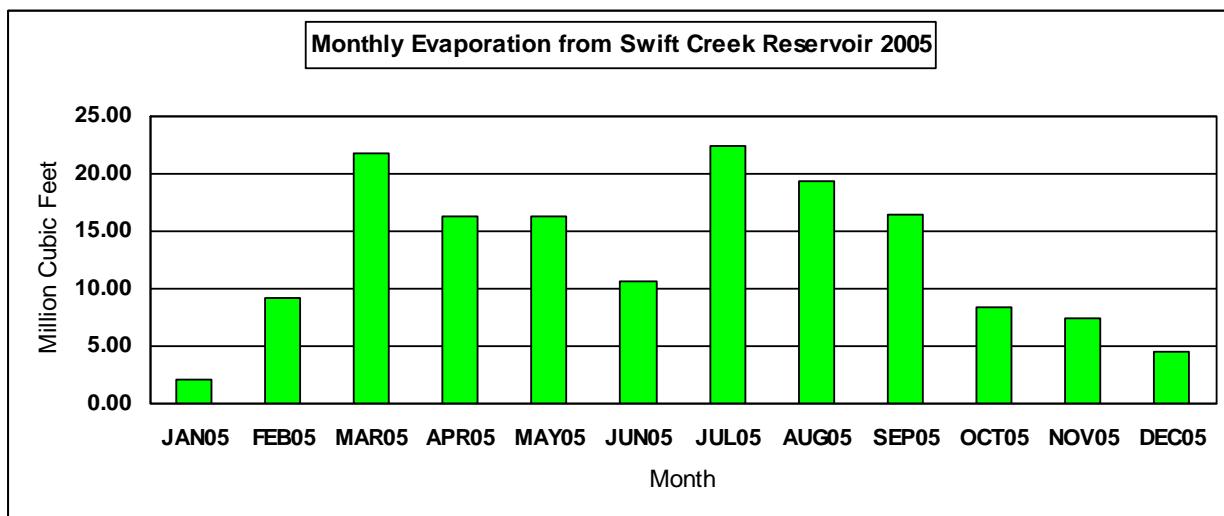
## **Chestnut Bluff Terrace Direct Runoff Site (Woodlake)**

**Table 3-4. Drainage Area, Discharge, and Runoff Data for Direct Runoff Areas**

<b>Direct Runoff Area</b>	<b>Drainage Area</b>	<b>Total Annual</b>	<b>Runoff</b>
	(sq. miles)	Discharge (Mft <sup>3</sup> )	(Mft <sup>3</sup> /mi <sup>2</sup> )
1	2.54	25.1	9.9
2	2.12	21.1	9.9
3	0.76	15.1	19.9
4	7.34	145.5	19.8
<b>Total</b>	<b>12.76</b>	<b>206.89</b>	<b>16.2</b>

**Table 3-5. 2005 Rainfall Gain to Swift Creek Reservoir**

Annual Mean Rainfall (inches)	35.36
Total Gain (feet)	2.95
Reservoir Area (2.54 sq. mi. = sq. feet)	70,811,136
Lake Gain (cubic feet/year)	208,656,814
Lake Gain (million cubic feet/year)	208.7



**Figure 3-3. 2005 Monthly Evaporation from Swift Creek Reservoir.**

Table 3-6a. 2005 daily mean discharges (cubic feet/second) for sites within the Swift Creek Reservoir Watershed. Bold values indicate estimated flow.

## Swift Creek Dam Spillway

Table 3-6b. 2005 daily mean discharges (cubic feet/second) for sites within the Swift Creek Reservoir Watershed. Bold values indicate estimated flow.

**Swift Creek Dam Spillway Seepage**

<u>Day</u>	<u>January</u>	<u>February</u>	<u>March</u>	<u>April</u>	<u>May</u>	<u>June</u>	<u>July</u>	<u>August</u>	<u>September</u>	<u>October</u>	<u>November</u>	<u>December</u>
1	0.000	0.000	0.000	0.000	0.000	0.000	0.048	0.062	0.039	0.000	0.000	0.017
2	0.000	0.000	0.000	0.000	0.000	0.000	0.044	0.057	0.039	0.000	0.000	0.021
3	0.000	0.000	0.000	0.000	0.000	0.000	0.044	0.057	0.035	0.000	0.000	0.021
4	0.000	0.000	0.000	0.000	0.000	0.000	0.044	0.057	0.035	0.000	0.000	0.021
5	0.000	0.000	0.000	0.000	0.000	0.000	0.039	0.057	0.035	0.000	0.000	0.026
6	0.000	0.000	0.000	0.000	0.000	0.000	0.039	0.053	0.030	0.000	0.000	0.030
7	0.000	0.000	0.000	0.000	0.000	0.000	0.039	0.053	0.030	0.000	0.000	0.030
8	0.000	0.000	0.000	0.000	0.000	0.000	0.071	0.053	0.030	0.008	0.000	0.030
9	0.000	0.000	0.000	0.000	0.000	0.080	0.080	0.053	0.026	0.008	0.000	0.035
10	0.000	0.000	0.000	0.000	0.000	0.080	0.075	0.053	0.026	0.008	0.000	0.044
11	0.000	0.000	0.000	0.000	0.000	0.075	0.075	0.053	0.026	0.008	0.000	0.048
12	0.000	0.000	0.000	0.000	0.000	0.075	0.075	0.048	0.026	0.008	0.000	0.048
13	0.000	0.000	0.000	0.000	0.000	0.075	0.075	0.048	0.021	0.008	0.000	0.048
14	0.000	0.000	0.000	0.000	0.000	0.071	0.075	0.048	0.021	0.008	0.000	0.053
15	0.000	0.000	0.000	0.000	0.000	0.071	0.080	0.048	0.012	0.008	0.000	0.053
16	0.000	0.000	0.000	0.000	0.000	0.071	0.075	0.048	0.008	0.008	0.000	0.000
17	0.000	0.000	0.000	0.000	0.000	0.066	0.075	0.053	0.008	0.003	0.000	0.000
18	0.000	0.000	0.000	0.000	0.000	0.066	0.075	0.048	0.008	0.003	0.000	0.000
19	0.000	0.000	0.000	0.000	0.000	0.066	0.071	0.053	0.008	0.003	0.000	0.000
20	0.000	0.000	0.000	0.000	0.000	0.062	0.071	0.053	0.008	0.003	0.000	0.000
21	0.000	0.000	0.000	0.000	0.000	0.062	0.071	0.053	0.003	0.003	0.000	0.000
22	0.000	0.000	0.000	0.000	0.000	0.062	0.071	0.048	0.003	0.003	0.000	0.000
23	0.000	0.000	0.000	0.000	0.000	0.057	0.066	0.048	0.003	0.000	0.003	0.000
24	0.000	0.000	0.000	0.000	0.000	0.057	0.066	0.048	0.003	0.000	0.003	0.000
25	0.000	0.000	0.000	0.000	0.000	0.057	0.066	0.048	0.000	0.003	0.003	0.000
26	0.000	0.000	0.000	0.000	0.000	0.053	0.066	0.044	0.000	0.003	0.003	0.000
27	0.000	0.000	0.000	0.000	0.000	0.053	0.062	0.044	0.000	0.003	0.003	0.000
28	0.000	0.000	0.000	0.000	0.000	0.048	0.062	0.044	0.000	0.003	0.003	0.000
29	0.000	0.000	0.000	0.000	0.000	0.048	0.062	0.044	0.000	0.003	0.003	0.000
30	0.000	0.000	0.000	0.000	0.000	0.048	0.062	0.039	0.000	0.003	0.012	0.000
31	0.000	0.000	0.000	0.000	0.000	0.062	0.039	0.000	0.000	0.000	0.000	0.000
<b>Mean</b>	0.00	0.00	0.00	0.00	0.00	0.05	0.06	0.05	0.02	0.00	0.00	0.02
<b>Max</b>	0.00	0.00	0.00	0.00	0.00	0.08	0.08	0.06	0.04	0.01	0.01	0.05
<b>Min</b>	0.00	0.00	0.00	0.00	0.00	0.00	0.04	0.04	0.00	0.00	0.00	0.00

**Table 3-7. Monthly and Annual Evaporation Totals Determined at Swift Creek Reservoir.**  
**Evaporation Measured by Hook Gage and Class A Evaporation Pan**

Month	Average Reservoir Elevation	Reservoir Surface Area	Reservoir Surface Area	Pan Area	Monthly Total Evaporation	Monthly Total Evaporation	Monthly Total Evaporation	Monthly Total Evaporation (Adjusted by 0.74 coeff)
	Level Feet MSL	acres	square feet	square feet	inches	feet	million cubic feet	Million Cubic Feet
JAN05	177.2	1609	70,067,679	12.57	-0.482	-0.04	-2.81	-2.08
FEB05	177.3	1599	69,641,329	12.57	-2.144	-0.18	-12.44	-9.21
MAR05	177.3	1609	70,067,679	12.57	-5.047	-0.42	-29.47	-21.81
APR05	177.3	1599	69,641,329	12.57	-3.782	-0.32	-21.95	-16.24
MAY05	177.2	1599	69,641,329	12.57	-3.787	-0.32	-21.98	-16.26
JUN05	177.2	1560	67,935,926	12.57	-2.527	-0.21	-14.31	-10.59
JUL05	177.3	1550	67,509,575	12.57	-5.393	-0.45	-30.34	-22.45
AUG05	177.5	1520	66,230,523	12.57	-4.745	-0.40	-26.19	-19.38
SEP05	177.4	1442	62,819,717	12.57	-4.238	-0.35	-22.19	-16.42
OCT05	177.1	1413	61,540,664	12.57	-2.205	-0.18	-11.31	-8.37
NOV05	177.3	1403	61,114,314	12.57	-1.960	-0.16	-9.98	-7.39
DEC05	177.3	1540	67,083,224	12.57	-1.074	-0.09	-6.00	-4.44

#### ***Evaluation of the 2005 Water Budget***

Rainfall was significantly below the long term median of 41 inches per year, resulting in inputs which were correspondingly low (Table 3-8). Rainfall for 2005 was lower than all other years since 1997, except for the drought of 2002, which started in fall 2001. The reduction in rainfall results in reduced rainfall directly into the reservoir and reduced runoff from the surrounding watersheds. The input from runoff from direct drainage areas and direct precipitation was the lowest recorded since 1997, except during the 2002 drought.

The discharges from the wetlands adjacent to Swift Creek Reservoir have been estimated in the past at approximately 32 Mft<sup>3</sup>. In 2005, actual monitoring of the velocities and depths through the culverts at the wetlands indicated a flow of 86 Mft<sup>3</sup>. This represented an input greater than the tributary inputs from Otterdale, Westbranch, Horsepen, Ashbrook, Dry and Blackman Creeks. The monitoring of the flow through the wetland pipes was a substantial improvement to the water budget.

Evaporation was the second highest on record since 1997. Plant withdrawals were above the historical record. The golf course irrigation was within historical ranges. The discharge over the spillway dam was within the range of historical data and just above the long term median.

The water budget indicates a surplus of 716 Mft<sup>3</sup> leaving the reservoir which is not accounted for in the estimate of water inputs to the reservoir. This discrepancy has been consistently observed in all but the driest years, and the magnitude increases greatly during the highest rainfall years. This discrepancy is primarily the result of the following cumulative errors:

- Under estimation of inputs from groundwater
- Under estimation of storm flows at tributary stations
- Under estimation of flows from Direct Runoff Areas
- Errors associated with changes in the stage-discharge curves of the tributaries, especially those that are sand bed streams.

**Table 3-8. A Comparison of Water Budget Characteristics over the Past Eight Years**

Inputs	1997 Mft <sup>3</sup>	1998 Mft <sup>3</sup>	1999 Mft <sup>3</sup>	2000 Mft <sup>3</sup>	2001 Mft <sup>3</sup>	2002 Mft <sup>3</sup>	2003 Mft <sup>3</sup>	2004 Mft <sup>3</sup>	2005 Mft <sup>3</sup>
Monitored Tributaries	986	1581	844	931	809	564	2654	1689	984
Direct Runoff Areas	225	483	274	279	244	148	557	418	207
Precipitation	218	284	280	241	179	210	369	326	209
Wetland Seepage	*	*	*	29	58	32	32	284	86
Groundwater Seepage	*	16	3	3	*	*	*	*	*
<b>Total</b>	<b>1429</b>	<b>2364</b>	<b>1400</b>	<b>1481</b>	<b>1289</b>	<b>954</b>	<b>3612</b>	<b>2717</b>	<b>1485</b>
Outputs	Mft <sup>3</sup>								
Evaporation	164	149	97	102	98	102	102	152	155
Plant Withdrawals	392	392	398	492	417	270	393	401	445
Golf Course Irrigation	3	3	2	2	3	2	2	1	2
Overflow	1454	2460	1075	1308	1053	234	5706	5980	1598
Leakage	4	1	1	1	1	0	0	0	0
Flood Control Release	*	51	*	30	*	*	*	*	*
<b>Total</b>	<b>2017</b>	<b>3056</b>	<b>1573</b>	<b>1934</b>	<b>1572</b>	<b>608</b>	<b>6203</b>	<b>6534</b>	<b>2197</b>
Change in Storage	-97	-205	306	-95	-191	291	0	0	0
Residual	<b>491</b>	<b>487</b>	<b>478</b>	<b>359</b>	<b>91</b>	<b>-54</b>	<b>2592</b>	<b>3817</b>	<b>716</b>

\*Missing data points (Wetland Seepage not measured prior to 2000, Groundwater Seepage discontinued after 2000 and no Flood Control Releases occurred that year)

The discrepancy between the discharge at the spillway and what is estimated to enter the reservoir from the tributaries results in an underestimation of the phosphorous loading to the reservoir. If the tributary flows are under estimated, then the associated loadings of phosphorous have been under estimated.

# **Chapter 4: References**

## **REFERENCES:**

---

### **Reports on Swift Creek Reservoir Watershed:**

CDM, 1990. Final Report: Watershed Management Study for Swift Creek Reservoir. Camp, Dresser, & McKee. Annandale, Virginia.

CH2M Hill, 1999. Swift Creek Reservoir Watershed Management Plan, Hydrologic and Water Quality Modeling. Technical Memorandum to Chesterfield County, Virginia.

Chesterfield County Utilities, Swift Creek Water Treatment Plant, 2002. Hydrologic and Water Quality Characteristics of the Swift Creek Reservoir and Watershed 2000. Addison-Evans Water Production & Laboratory Facility Laboratory, Midlothian, Virginia

Chesterfield County Utilities, Swift Creek Water Treatment Plant, 2000. Hydrologic and Water Quality Characteristics of the Swift Creek Reservoir and Watershed 1998. Addison-Evans Water Production & Laboratory Facility Laboratory, Midlothian, Virginia.

Chesterfield County Utilities, Swift Creek Water Treatment Plant, 1999. Hydrologic and Water Quality Characteristics of the Swift Creek Reservoir and Watershed 1997. Addison-Evans Water Production & Laboratory Facility Laboratory, Midlothian, Virginia.

Hoehn, R. C., T. J. Grizzard, and K. A. McArthur, 1998. Hydrologic and Water Quality Characteristics of the Swift Creek Reservoir and Watershed 1996. Virginia Tech. Department of Civil and Environmental Engineering and Occoquan Watershed Monitoring Laboratory. Blacksburg and Manassas, Virginia.

OWML, 1997. Hydrologic and Water Quality Characteristics of the Swift Creek Watershed July 1993 - December 1994. Occoquan Watershed Monitoring Laboratory. Manassas, Virginia.

OWML, 1998. Hydrologic and Water Quality Characteristics of the Swift Creek Watershed January 1995 - December 1995. Occoquan Watershed Monitoring Laboratory. Manassas, Virginia.

Smock, Leonard A., 1986. Biological Assessment of Swift Creek Reservoir Water Quality. Department of Biology, Virginia Commonwealth University. Report to Chesterfield County, Virginia.

Smock, Leonard A. and Silvia B. Gazzera, 1992. Hydrologic and Water Quality Characteristics of the Swift Creek Reservoir Watershed 1991-1992. Department of Biology, Virginia Commonwealth University. Report to Chesterfield County, Virginia.

Smock, Leonard A. and Silvia B. Gazzera, 1993. Hydrologic and Water Quality Characteristics of the Swift Creek Reservoir Watershed 1992-1993. Department of Biology, Virginia Commonwealth University. Report to Chesterfield County, Virginia.

Skrobialowski, S. C. and M. J. Focazio, 1997. Hydrologic Characteristics and Water Budget for Swift Creek Reservoir, Virginia, 1996. Open-File Report 97-229. U. S. Geological Survey. Richmond, Virginia.

Skrobialowski, S. C., 1998. Hydrologic Characteristics and Water Budget for Swift Creek Reservoir, Virginia, 1997. Water resources Investigations Report 98-4122. U. S. Geological Survey. Richmond, Virginia.

#### **General References:**

APHA, 1995. Standard Methods for the Examination of Water and Wastewater. 19th edition. American Public Health Association, American Water Works Association, and the Water Environment Federation. Washington, D.C.

Hux, Dustin, 1998. Personal Communication, Virginia State Climatology Office, University of Virginia, Charlottesville, Virginia.

Leitch, Katherine M., 1998. Estimating Tributary Phosphorus Loads Using Flow-Weighted Composite Storm Sampling. Journal of the American Water Resources Association (in press).

Taylor, J.K. 1987. Quality Assurance of Chemical Measurements. Lewis Publishers, Inc., Chelsea, MI. 79-82.

Virginia Water Resources Center. 2005. January 2005 Report of the Academic Advisory Committee to Virginia Department of Environmental Quality: Freshwater Nutrient Criteria.

# **Appendix A: Tributary, Wetfall, & Dryfall Data by Date**

**CHESTERFIELD COUNTY UTILITIES DEPARTMENT  
ADDISON-EVANS WATER PRODUCTION AND LABORATORY FACILITY**

**SWIFT CREEK RESERVOIR WATERSHED ATMOSPHERIC NUTRIENT INPUTS (WETFALL)**

PERIOD: January - December 2005

AREA OF BUCKET OPENING (m<sup>2</sup>)

0.0647

DATE	EVENT RAINFALL (Inches)	RAIN pH	RAINFALL VOLUME (LITERS)	TOTAL *		TOTAL KJELDAHL		TOTAL OXIDIZED		TOTAL PHOSPHORUS		ORTHO PHOSPHATE	
				TOTAL *		NITROGEN		KJELDAHL		NITROGEN		OXIDIZED	
				RAINFALL	VOLUME	NITROGEN	NITROGEN	NITROGEN	NITROGEN	PHOSPHORUS	PHOSPHORUS	PHOSPHORUS	PHOSPHORUS
01/18/05	1.99	5.3	3.20	0.34	16.62	0.22	10.68	0.12	5.94	0.008	0.40	0.006	0.30
01/26/05	0.35	4.12	0.60	**	**	0.52	4.86	**	**	0.022	0.20	0.008	0.07
02/02/05	0.70	4.7	1.00	1.07	16.58	0.31	4.84	0.76	11.75	0.0025	0.04	0.0025	0.04
02/16/05	0.39	4.5	0.32	1.68	8.20	0.28	1.38	1.40	6.82	0.012	0.06	0.0025	0.01
03/04/05	1.44	4.71	2.00	1.71	52.89	0.41	12.70	1.30	40.19	0.083	2.57	0.062	1.92
03/15/05	1.32	4.64	2.00	2.64	81.45	0.24	7.26	2.40	74.19	0.043	1.33	0.025	0.77
03/30/05	1.87	4.41	3.50	0.81	43.66	0.35	18.77	0.46	24.88	0.0025	0.14	0.0025	0.14
04/05/05	0.62	5.6	0.75	0.32	3.70	0.21	2.42	0.11	1.28	0.075	0.87	0.07	0.81
04/14/05	0.64	3.52	0.35	1.19	6.45	0.38	2.04	0.82	4.41	0.018	0.10	0.0025	0.01
04/28/05	0.73	4.4	1.00	1.42	21.93	0.29	4.47	1.13	17.47	0.107	1.65	0.011	0.17
05/02/05	0.99	4.75	1.75	0.33	8.98	0.21	5.65	0.12	3.33	0.013	0.35	0.007	0.19
05/26/05	1.87	4.45	3.10	0.96	46.14	0.31	14.95	0.65	31.19	**	**	0.007	0.34
06/06/05	0.45	4.77	0.90	0.62	8.57	0.28	3.87	0.34	4.70	0.008	0.11	0.0025	0.03
07/05/05	0.76	4.2	0.75	1.38	16.02	0.22	2.57	1.16	13.45	0.048	0.56	0.033	0.38
07/11/05	3.72	4.51	6.00	0.49	45.81	0.30	28.10	0.19	17.71	0.0025	0.23	0.0025	0.23
07/18/05	1.29	4.27	1.20	1.15	21.27	0.82	15.19	0.33	6.08	0.060	1.11	0.0025	0.05
08/03/05	0.59	4.12	0.70	0.73	7.88	0.22	2.41	0.51	5.46	**	**	0.007	0.08
08/18/05	2.13	4.36	3.10	0.53	25.44	0.23	11.02	0.30	14.42	**	**	0.0025	0.12
10/13/05	3.44	4.97	6.10	0.19	17.91	0.14	13.20	0.05	4.71	0.008	0.75	0.014	1.32
10/26/05	1.3	4.72	1.90	0.23	6.75	0.08	2.35	0.15	4.40	0.0025	0.07	0.0025	0.07
11/28/05	1.81	4.90	2.10	0.39	12.66	0.14	4.54	0.25	8.11	0.0025	0.08	**	**
12/01/05	0.88	5.37	0.95	0.13	1.91	0.07	1.03	0.06	0.88	0.0025	0.04	0.005	0.07
12/13/05	1.95	4.45	3.30	0.49	24.99	0.48	24.48	0.01	0.51	**	**	0.354	18.06
12/19/05	1.84	4.89	2.65	0.37	15.15	0.26	10.65	0.11	4.51	0.0025	0.10	**	**
12/27/05	1.82	4.91	1.20	0.28	5.19	0.27	5.01	0.01	0.19	0.0025	0.05	**	**

\* TOTAL NITROGEN IS CALCULATED AS THE SUM OF TOTAL KJELDAHL NITROGEN AND TOTAL OXIDIZED NITROGEN

\*\* DATA MISSING OR OMITTED DUE TO CONTAMINATION

Results less than Detection limit were included as 1/2 D.L.

**CHESTERFIELD COUNTY UTILITIES DEPARTMENT**  
**ADDISON-EVANS WATER PRODUCTION AND LABORATORY FACILITY**

**SWIFT CREEK RESERVOIR WATERSHED ATMOSPHERIC NUTRIENT INPUTS (DRYFALL)**

PERIOD: January 2005 - December 2005

AREA OF BUCKET OPENING (m<sup>2</sup>): 0.0647

PERIOD OF DRYFALL (start)	DAYS (finish)	BUCKET (-1 wet day )	VOLUME (L)	TOTAL *		TOTAL KJELDAHL		TOTAL OXIDIZED		TOTAL PHOSPHORUS		ORTHO	
				NITROGEN		NITROGEN		NITROGEN		PHOSPHORUS		PHOSPHORUS	
				(mg/L as N)	(mg/m <sup>2</sup> /day)	(mg/L as N)	(mg/m <sup>2</sup> /day)	(mg/L as N)	(mg/m <sup>2</sup> /day)	(mg/L as P)	(mg/m <sup>2</sup> /day)	(mg/L as P)	(mg/m <sup>2</sup> /day)
01/03/05	01/12/05	9	0.500	0.51	0.43	0.37	0.31	0.14	0.12	0.020	0.017	0.014	0.01
01/12/05	02/02/05	19	0.500	0.67	0.27	0.51	0.21	0.16	0.07	0.342	0.139	0.264	0.11
02/02/05	02/16/05	13	0.500	1.00	0.59	0.40	0.24	0.60	0.36	0.389	0.231	0.372	0.22
02/16/05	03/15/05	28	0.500	1.07	0.30	0.19	0.05	0.88	0.24	0.149	0.041	0.083	0.02
03/15/05	03/30/05	14	0.500	1.19	0.66	0.21	0.12	0.98	0.54	0.019	0.010	0.007	0.00
03/30/05	04/05/05	4	0.500	2.01	3.89	0.41	0.80	1.60	3.09	0.313	0.605	0.22	0.43
04/05/05	04/14/05	8	0.500	0.46	0.45	0.31	0.30	0.15	0.14	0.037	0.036	0.026	0.03
04/14/05	04/28/05	13	0.500	0.91	0.54	0.51	0.30	0.40	0.24	1.48	0.880	0.628	0.37
04/28/05	05/02/05	3	0.500	1.25	3.22	0.42	1.08	0.83	2.14	**	**	0.442	1.14
05/02/05	05/11/05	8	0.500	0.41	0.39	0.31	0.30	0.10	0.09	**	**	**	**
05/11/05	05/26/05	14	0.500	0.63	0.35	0.53	0.29	0.10	0.06	0.616	0.340	0.529	0.29
05/26/05	06/06/05	9	0.500	0.67	0.58	0.56	0.48	0.12	0.10	**	**	**	**
06/06/05	06/20/05	13	0.500	0.81	0.48	0.51	0.30	0.30	0.18	**	**	**	**
06/20/05	07/05/05	14	0.500	0.80	0.44	0.69	0.38	0.12	0.06	0.763	0.421	0.711	0.39
07/05/05	07/11/05	5	0.500	1.03	1.59	0.73	1.12	0.30	0.47	**	**	0.148	0.23
07/11/05	07/18/05	6	0.500	1.16	1.49	1.14	1.47	0.02	0.02	0.491	0.632	0.458	0.59
07/18/05	08/03/05	14	0.500	1.19	0.66	1.09	0.60	0.10	0.06	0.637	0.352	**	**
08/03/05	08/18/05	14	0.500	0.90	0.50	0.90	0.50	<0.10	0.00	**	**	0.117	0.06
08/18/05	09/07/05	18	0.500	5.41	2.32	5.25	2.25	0.16	0.07	**	**	**	**
09/07/05	09/19/05	11	0.500	3.31	2.33	3.08	2.16	0.23	0.16	0.678	0.48	**	**
09/19/05	10/04/05	14	0.500	0.00	0.00	**	**	**	**	**	**	**	**
10/04/05	10/13/05	8	0.500	2.14	2.07	2.05	1.98	0.09	0.09	0.677	0.65	0.337	0.33
10/13/05	10/26/05	12	0.500	2.38	1.53	2.31	1.49	0.07	0.05	0.224	0.14	0.017	0.01
10/26/05	11/01/05	4	0.500	1.00	1.93	0.55	1.06	0.45	0.87	0.03	0.06	0.024	0.05
11/01/05	11/14/05	12	0.500	3.31	2.13	3.28	2.11	0.03	0.02	0.1	0.06	0.069	0.04
11/14/05	11/28/05	13	0.500	1.56	0.93	1.44	0.86	0.12	0.07	0.327	0.19	0.116	0.07
11/28/05	12/01/05	2	0.500	14.82	57.26	14.5	56.03	0.32	1.24	1.37	5.29	0.226	0.87
12/01/05	12/13/05	11	0.500	0.13	0.09	0.07	0.05	0.06	0.04	0.0025	0.00	0.002	0.00
12/13/05	12/19/05	5	0.500	0.54	0.83	0.24	0.37	0.30	0.46	**	**	0.047	0.07
12/19/05	12/27/05	7	0.500	0.49	0.54	0.27	0.30	0.22	0.24	0.0025	0.00	**	**

\* Total nitrogen is calculated as the sum of total kjeldahl nitrogen and total oxidized nitrogen

\*\* Data excluded due to analytical error or suspected contamination.

Results less than Detection limit were included as 1/2 D.L.

**CHESTERFIELD COUNTY UTILITIES DEPARTMENT  
ADDISON-EVANS WATER PRODUCTION AND LABORATORY FACILITY**

**ATMOSPHERIC NUTRIENT INPUTS OUTLIER ANALYSIS  
PERIOD: January - December 2005**

WETFALL Concentrations				WETFALL Loads			
Event Date(s)	Total Phosphorus (mg/L as P)	T-Stat		Event Date(s)	Total Phosphorus (mg/m <sup>2</sup> /day)	T-Stat	
		High	Low			High	Low
02/02/05	0.0025	-0.712	0.712	12/01/05	0.04	-0.719	0.719
03/30/05	0.0025	-0.712	0.712	02/02/05	0.04	-0.716	0.716
07/11/05	0.0025	-0.712	0.712	12/27/05	0.05	-0.704	0.704
10/26/05	0.0025	-0.712	0.712	02/16/05	0.06	-0.686	0.686
11/28/05	0.0025	-0.712	0.712	10/26/05	0.07	-0.663	0.663
12/01/05	0.0025	-0.712	0.712	11/28/05	0.08	-0.652	0.652
12/19/05	0.0025	-0.712	0.712	04/14/05	0.10	-0.627	0.627
12/27/05	0.0025	-0.712	0.712	12/19/05	0.10	-0.620	0.620
01/18/05	0.008	-0.538	0.538	06/06/05	0.11	-0.606	0.606
06/06/05	0.008	-0.538	0.538	03/30/05	0.14	-0.570	0.570
10/13/05	0.008	-0.538	0.538	01/26/05	0.20	-0.467	0.467
02/16/05	0.012	-0.412	0.412	07/11/05	0.23	-0.425	0.425
05/02/05	0.013	-0.380	0.380	05/02/05	0.35	-0.245	0.245
04/14/05	0.018	-0.222	0.222	01/18/05	0.40	-0.179	0.179
01/26/05	0.022	-0.095	0.095	07/05/05	0.56	0.063	-0.063
03/15/05	0.043	0.570	-0.570	10/13/05	0.75	0.360	-0.360
07/05/05	0.048	0.728	-0.728	04/05/05	0.87	0.534	-0.534
07/18/05	0.060	1.108	-1.108	07/18/05	1.11	0.900	-0.900
04/05/05	0.075	1.583	-1.583	03/15/05	1.33	1.225	-1.225
03/04/05	0.083	1.108	-1.108	04/28/05	1.65	1.713	-1.713
04/28/05	0.107	1.583	-1.583	03/04/05	2.57	3.085	-3.085

**Outlier**

DRYFALL Concentrations				DRYFALL Loads			
Event Date(s)	Total Phosphorus (mg/L as P)	T-Stat		Event Date(s)	Total Phosphorus (mg/m <sup>2</sup> /day)	T-Stat	
		High	Low			High	Low
12/01/05	0.0025	-0.970	0.970	12/01/05	0.000	-0.447	0.447
12/19/05	0.0025	-0.970	0.970	12/19/05	0.000	-0.447	0.447
03/15/05	0.019	-0.931	0.931	03/15/05	0.010	-0.438	0.438
01/03/05	0.020	-0.929	0.929	01/03/05	0.017	-0.432	0.432
10/26/05	0.030	-0.905	0.905	04/05/05	0.036	-0.415	0.415
04/05/05	0.037	-0.889	0.889	02/16/05	0.041	-0.411	0.411
11/01/05	0.100	-0.740	0.740	10/26/05	0.058	-0.396	0.396
02/16/05	0.149	-0.624	0.624	11/01/05	0.064	-0.390	0.390
10/13/05	0.224	-0.446	0.446	01/12/05	0.139	-0.324	0.324
03/30/05	0.313	-0.236	0.236	10/13/05	0.144	-0.319	0.319
11/14/05	0.327	-0.203	0.203	11/14/05	0.194	-0.275	0.275
01/12/05	0.342	-0.167	0.167	02/02/05	0.231	-0.242	0.242
02/02/05	0.389	-0.056	0.056	05/11/05	0.340	-0.146	0.146
07/11/05	0.491	0.185	-0.185	07/18/05	0.352	-0.135	0.135
05/11/05	0.616	0.481	-0.481	06/20/05	0.421	-0.074	0.074
07/18/05	0.637	0.530	-0.530	09/07/05	0.476	-0.025	0.025
10/04/05	0.677	0.625	-0.625	03/30/05	0.605	0.089	-0.089
09/07/05	0.678	0.627	-0.627	07/11/05	0.632	0.114	-0.114
06/20/05	0.763	0.828	-0.828	10/04/05	0.654	0.133	-0.133
11/28/05	1.370	2.264	-2.264	04/14/05	0.880	0.333	-0.333
04/14/05	1.480	2.524	-2.524	11/28/05	5.294	4.247	-4.247

**Outlier**

WETFALL Concentrations				WETFALL Loads			
Event Date(s)	Total Phosphorus (mg/L as P)	T-Stat		Event Date(s)	Total Phosphorus (mg/m <sup>2</sup> /day)	T-Stat	
		High	Low			High	Low
MEAN	0.03			MEAN	0.51		
STANDARD DEVIATION	0.032			STANDARD DEVIATION	0.665		
n	21			n	21		
Outlier	0.10			Outlier	2.18		

DRYFALL Concentrations				DRYFALL Loads			
Event Date(s)	Total Phosphorus (mg/L as P)	T-Stat		Event Date(s)	Total Phosphorus (mg/m <sup>2</sup> /day)	T-Stat	
		High	Low			High	Low
MEAN	0.41			MEAN	0.50		
STANDARD DEVIATION	0.423			STANDARD DEVIATION	1.128		
n	21			n	21		
Outlier	1.47			Outlier	3.32		

**CHESTERFIELD COUNTY UTILITIES DEPARTMENT  
SWIFT CREEK WATER TREATMENT PLANT LABORATORY  
PERIOD: JANUARY - DECEMBER 2005**

---



---

WETFALL Events Date(s)	TOTAL PHOSPHORUS		LEVEL Ft. M.S.L.	RESERVOIR SURFACE AREA		TOTAL PHOSPHORUS LOAD	
	(mg/L as P)	(mg/m <sup>2</sup> as P)		Acres	m <sup>2</sup>	(mg as P)	(LBS)
01/18/05	0.01	0.40	176.86	1565	6,335,220	2,506,671	5.53
01/26/05	0.02	0.20	176.81	1561	6,315,415	1,288,462	2.84
02/02/05	0.00	0.04	176.87	1566	6,339,181	244,945	0.54
02/16/05	0.01	0.06	176.78	1558	6,303,532	368,274	0.81
03/15/05	0.04	1.33	176.82	1562	6,319,376	8,399,789	18.52
03/30/05	0.00	0.14	177.01	1580	6,394,634	864,807	1.91
04/05/05	0.08	0.87	176.85	1559	6,307,493	5,483,717	12.09
04/14/05	0.02	0.10	176.79	1551	6,275,806	611,091	1.35
04/28/05	0.11	1.65	176.71	1565	6,335,220	10,477,102	23.10
05/02/05	0.01	0.35	176.86	1565	6,335,220	2,227,608	4.91
06/06/05	0.01	0.11	176.65	1452	5,875,752	653,870	1.44
07/05/05	0.05	0.56	175.70	1452	5,875,752	3,269,352	7.21
07/11/05	0.00	0.23	176.51	1531	6,196,587	1,436,612	3.17
07/18/05	0.06	1.11	176.45	1525	6,172,822	6,869,291	15.15
10/13/05	0.01	0.75	175.21	1404	5,681,666	4,285,399	9.45
10/26/05	0.00	0.07	175.10	1393	5,638,096	413,925	0.91
11/28/05	0.00	0.08	175.06	1389	5,622,253	456,211	1.01
12/01/05	0.00	0.04	175.43	1426	5,768,807	211,761	0.47
12/19/05	0.00	0.10	177.21	1600	6,473,852	662,894	1.46
12/27/05	0.0025	0.05	177.25	1604	6,489,696	300,913	0.66
<b>TOTAL</b>							<b>112.53</b>

**CHESTERFIELD COUNTY UTILITIES DEPARTMENT**  
**SWIFT CREEK WATER TREATMENT PLANT LABORATORY**  
 PERIOD: JANUARY - DECEMBER 2005

DRYFALL Events Date(s)	TOTAL PHOSPHORUS		LEVEL <u>Ft. M.S.L.</u>	RESERVOIR		TOTAL PHOSPHORUS LOAD	
	(mg/L as P)	(mg/m <sup>2</sup> as P)		<u>Acres</u>	<u>m<sup>2</sup></u>	(mg as P)	(LBS)
01/03/05	0.020	0.017	176.75	1555	6,291,649	108,048	0.24
01/12/05	0.342	0.139	176.76	1556	6,295,610	875,742	1.93
02/02/05	0.389	0.231	176.87	1566	6,339,181	1,465,903	3.23
02/16/05	0.149	0.041	176.78	1558	6,303,532	259,226	0.57
03/15/05	0.019	0.010	176.82	1562	6,319,376	66,277	0.15
03/30/05	0.313	0.605	177.01	1580	6,394,634	3,866,925	8.53
04/05/05	0.037	0.036	176.85	1564	6,331,259	226,291	0.50
04/14/05	1.480	0.880	176.79	1559	6,307,493	5,549,334	12.24
05/11/05	0.616	0.340	176.70	1550	6,271,845	2,132,621	4.70
06/20/05	0.763	0.421	176.20	1501	6,073,798	2,558,130	5.64
07/11/05	0.491	0.632	176.51	1531	6,196,587	3,918,759	8.64
07/18/05	0.637	0.352	176.45	1525	6,172,822	2,170,505	4.79
09/07/05	0.678	0.476	175.47	1429	5,784,651	2,755,370	6.08
10/04/05	0.677	0.654	174.76	1360	5,503,425	3,599,129	7.94
10/13/05	0.224	0.144	175.21	1404	5,681,666	819,612	1.81
10/26/05	0.030	0.058	175.10	1393	5,638,096	326,783	0.72
11/01/05	0.100	0.064	174.99	1382	5,594,526	360,286	0.79
11/14/05	0.327	0.194	174.75	1359	5,499,464	1,069,031	2.36
12/01/05	0.003	0.002	175.43	1426	5,768,807	10,132	0.02
12/19/05	0.003	0.003	177.21	1600	6,473,852	17,868	0.04
<b>TOTALS</b>						<b>70.90</b>	

**CHESTERFIELD COUNTY UTILITIES DEPARTMENT  
SWIFT CREEK WATER TREATMENT PLANT LABORATORY  
PERIOD: JANUARY - DECEMBER 2005**

---



---

EVENT DATE(s)	TOTAL PHOSPHORUS LOAD (LBS)	Rain (inches)	n
<b>WETFALL</b>			
01/18/05	5.53	1.99	
01/26/05	2.84	0.35	
02/02/05	0.54	0.70	
02/16/05	0.81	0.39	
03/15/05	18.52	1.44	
03/30/05	1.91	1.32	
<b>Winter</b>	<b>30.15</b>	<b>6.19</b>	<b>6</b>
04/05/05	12.09	0.62	
04/14/05	1.35	0.64	
04/28/05	23.10	0.73	
05/02/05	4.91	0.99	
05/26/05	1.44	1.87	
06/06/05	0.00	0.45	
<b>Spring</b>	<b>42.89</b>	<b>5.30</b>	<b>6</b>
07/05/05	7.21	0.76	
07/11/05	3.17	3.72	
07/18/05	15.15	1.29	
<b>Summer</b>	<b>25.52</b>	<b>5.77</b>	<b>3</b>
10/13/05	9.45	3.44	
10/26/05	0.91	1.30	
11/28/05	1.01	1.81	
12/01/05	0.47	0.88	
12/19/05	1.46	1.95	
12/27/05	0.66	1.84	
<b>Fall</b>	<b>13.96</b>	<b>11.22</b>	<b>6</b>

---

**CHESTERFIELD COUNTY UTILITIES DEPARTMENT  
SWIFT CREEK WATER TREATMENT PLANT LABORATORY  
PERIOD: JANUARY - DECEMBER 2005**

<b>Dryfall</b>		TOTAL PHOSPHORUS LOAD		
PERIOD OF DRYFALL <u>(start)</u>	<u>(finish)</u>	(LBS)	Dry Days	n
01/03/05	01/12/05	0.24	9	
01/12/05	02/02/05	1.93	19	
02/02/05	02/16/05	3.23	13	
02/16/05	03/15/05	0.57	28	
03/15/05	03/30/05	0.15	14	
03/30/05	04/05/05	8.53	4	
	<b>Winter</b>	<b>14.65</b>	<b>87</b>	<b>6</b>
04/05/05	04/14/05	0.50	8	
04/14/05	04/28/05	12.24	13	
05/11/05	05/26/05	4.70	14	
06/20/05	07/05/05	5.64	14	
	<b>Spring</b>	<b>23.08</b>	<b>49</b>	<b>4</b>
07/11/05	07/18/05	8.64	6	
07/18/05	08/03/05	4.79	14	
09/07/05	09/19/05	6.08	11	
	<b>Summer</b>	<b>31.00</b>	<b>31</b>	<b>1</b>
10/04/05	10/13/05	7.94	8	
10/13/05	10/26/05	1.81	12	
10/26/05	11/01/05	0.72	4	
11/01/05	11/14/05	0.79	12	
11/14/05	11/28/05	2.36	13	
12/01/05	12/13/05	0.02	2	
12/19/05	12/27/05	0.04	11	
	<b>Fall</b>	<b>5.74</b>	<b>54</b>	<b>6</b>

**Table 2-3. Seasonal atmospheric total phosphorus inputs to Swift Creek Reservoir (2005).**

Season	Wetfall Total			Dryfall Total		
	Phosphorus Load <u>(lbs)</u>	Rainfall <u>(inches)</u>	n	Phosphorus Load <u>(lbs)</u>	Dryfall Period <u>(Days)</u>	n
Winter	30	6.19	6	15	87	6
Spring	43	5.30	6	23	49	4
Summer	26	5.77	3	31	31	1
Autumn	14	11.22	6	6	54	6
<b>Annual</b>	<b>113</b>	<b>28.48</b>	<b>21</b>	<b>74</b>	<b>221</b>	<b>17</b>

Note: Some samples were excluded from loading calculations  
Rainfall and dry fall days are less than actual annual totals

RESULTS OF 2005 BASEFLOW & STORMFLOW SURVEY WATER QUALITY ANALYSES (JANUARY - DECEMBER)																		
STATION	DATE	TIME	SURVEY TYPE	FECAL	TOTAL	TOTAL KJELDAHL	OXIDIZED	TOTAL	ORTHOPHOSPHATE	TOTAL ORGANIC	TOTAL SUSPENDED	TURBIDITY	LEAD	ZINC	REMARKS			
				CONDUCTIVITY (micro-mhos/cm)	COLIFORM (Colonies / 100 mL)	NITROGEN* (mg/L)	NITROGEN (mg/L)	PHOSPHORUS (mg/L)	CARBON (mg/L)	SOLIDS (mg/L)								
1	01/03/05	13:30	Baseflow	6.61	54.8	37	0.24	0.21	0.03	0.014	0.012	3.51	4.3	11.9	< 0.0025	< 0.05		
2	01/03/05	10:00	Baseflow	6.15	54.2	93	0.23	0.20	0.03	0.013	0.013	3.43	< 2	3.76	< 0.0025	< 0.05		
3-I	01/03/05	12:40	Baseflow	6.12	28.6	35	0.20	0.20	< 0.01	0.009***	0.011	4.51	< 2	3.75	< 0.0025	< 0.05		
3-II	01/03/05	13:05	Baseflow	6.30	31.7	93	0.19	0.19	< 0.01	0.009***	0.011	4.55	2.4	4.34	< 0.0025	< 0.05		
4	01/03/05	12:15	Baseflow	5.91	30.4	27	0.26	0.21	0.05	0.013	0.011	3.94	< 2	4.25	< 0.0025	< 0.05		
5	01/03/05	11:50	Baseflow	6.71	42.4	8	0.22	0.19	0.03	0.018	0.012	3.29	2.8	6.18	< 0.0025	< 0.05		
6	01/03/05	11:25	Baseflow	6.31	33.7	35	0.33	0.23	0.10	0.011	0.010	2.45	4.0	6.24	< 0.0025	< 0.05		
7	01/03/05	11:00	Baseflow	6.44	36.9	13	0.28	0.22	0.06	0.011	0.010	1.69	2.6	6.96	< 0.0025	< 0.05		
8	01/03/05	13:50	Baseflow	6.81	32.2	4	0.33	0.33	< 0.01	0.022	0.010	4.73	5.0	7.44	< 0.0025	< 0.05		
13	01/03/05	10:30	Baseflow	6.22	70.3	210	0.55	0.18	0.37	0.014	0.008	1.56	11	3.02	< 0.0025	< 0.05		
14	01/03/05	10:15	Baseflow	6.59	64.5	192	0.55	0.18	0.37	0.011	0.008	1.41	< 2	1.40	< 0.0025	< 0.05		
1	01/18/05	14:00	Storm	6.39	41.2	172	0.31	0.24	0.07	0.065	0.016	**	90	79.6	< 0.0025	< 0.05	1.55 Inches Rain	
2	01/18/05	11:30	Storm	6.44	21.8	147	0.47	0.21	0.26	0.057	0.018	**	94	92.9	< 0.0025	< 0.05	1.55 Inches Rain	
3-I	01/18/05	13:30	Storm	5.93	24.4	26	0.22	0.22	< 0.01	0.035	0.010	**	74	36.4	< 0.0025	< 0.05	1.55 Inches Rain	
3-II	01/18/05	13:45	Storm	6.17	28.2	28	0.23	0.23	< 0.01	0.041	0.010	**	64	46.0	< 0.0025	< 0.05	1.55 Inches Rain	
4	01/18/05	13:25	Storm	5.97	28.3	41	0.29	0.24	0.05	0.018	0.010	**	4.0	15.4	< 0.0025	< 0.05	1.55 Inches Rain	
5	01/18/05	13:05	Storm	6.50	38.3	172	0.32	0.22	0.10	0.040	0.011	**	21	32.6	< 0.0025	< 0.05	1.55 Inches Rain	
6	01/18/05	12:45	Storm	6.33	32.4	35	0.47	0.26	0.21	0.026	0.009	**	150	21.8	< 0.0025	< 0.05	1.55 Inches Rain	
7	01/18/05	12:30	Storm	6.54	44.7	46	0.45	0.26	0.19	0.075	0.023	**	150	192	< 0.0025	< 0.05	1.55 Inches Rain	
8	01/18/05	14:15	Storm	6.34	28.0	>2419	0.43	0.41	0.02	0.032	0.009	**	6.5	18.4	< 0.0025	< 0.05	1.55 Inches Rain	
13	01/18/05	12:15	Storm	6.27	82.4	99	0.63	0.23	0.40	0.013	0.007	**	2.5	6.91	< 0.0025	< 0.05	1.55 Inches Rain	
14	01/18/05	11:50	Storm	6.50	25.9	135	0.98	0.22	0.76	0.009	0.006	**	< 2	2.98	< 0.0025	< 0.05	1.55 Inches Rain	
1	02/02/05	13:45	Baseflow	6.56	126	21	0.25	0.20	0.05	0.014	< 0.005	3.44	4.6	8.58	< 0.0025	< 0.05		
2	02/02/05	09:20	Baseflow	6.77	172	113	0.39	0.21	0.18	0.010	< 0.005	3.19	2.8	5.97	< 0.0025	< 0.05		
3-I	02/02/05	13:00	Baseflow	6.88	66.1	10	0.21	0.20	0.01	0.009	< 0.005	4.30	< 2	4.62	< 0.0025	< 0.05		
3-II	02/02/05	13:20	Baseflow	6.85	94.4	6	0.22	0.20	0.02	0.009	< 0.005	4.22	5.6	6.62	< 0.0025	< 0.05		
4	02/02/05	12:45	Baseflow	6.74	68.4	20	0.27	0.19	0.08	0.009	< 0.005	3.85	2.2	4.51	< 0.0025	< 0.05		
5	02/02/05	11:40	Baseflow	6.70	105	41	0.41	0.28	0.13	0.016	0.006	3.18	3.4	10.3	< 0.0025	< 0.05		
6	02/02/05	11:20	Baseflow	6.57	180	6	0.50	0.26	0.24	0.009	< 0.005	3.52	2.4	6.98	< 0.0025	< 0.05		
7	02/02/05	11:00	Baseflow	6.73	158	32	0.41	0.19	0.22	0.007	< 0.005	2.34	4.2	7.92	< 0.0025	< 0.05		
8	02/02/05	14:00	Baseflow	6.76	69.6	32	0.40	0.30	0.10	0.018	0.005	4.90	4.8	11.2	< 0.0025	< 0.05		
13	02/02/05	10:45	Baseflow	6.51	197	80	0.58	0.17	0.41	0.008	< 0.005	2.70	2.2	5.26	< 0.0025	< 0.05		
14	02/02/05	10:00	Baseflow	6.57	158	276	0.93	0.19	0.74	0.007	< 0.005	1.45	< 2	1.49	< 0.0025	< 0.05		
1	03/04/05	10:10	Baseflow	6.74	84.2	9	0.24	0.20	0.04	0.020	< 0.005	3.26	4.0	8.24	< 0.0025	< 0.05		
2	03/04/05	08:30	Baseflow	6.22	97.2	121	0.32	0.19	0.13	0.012	< 0.005	2.93	< 2	3.48	< 0.0025	< 0.05		
3-I	03/04/05	09:55	Baseflow	6.37	28.5	11	0.18	0.18	< 0.01	0.009	< 0.005	3.34	3.8	4.02	< 0.0025	< 0.05		
3-II	03/04/05	10:00	Baseflow	6.50	55.9	22	0.18	0.18	< 0.01	0.015	< 0.005	3.75	5.4	4.04	< 0.0025	< 0.05		
4	03/04/05	09:45	Baseflow	6.30	48.9	15	0.24	0.19	0.05	0.014	< 0.005	3.95	2.0	5.23	< 0.0025	< 0.05		
5	03/04/05	09:35	Baseflow	6.83	79.3	35	0.27	0.21	0.06	0.019	< 0.005	2.49</td						

RESULTS OF 2005 BASEFLOW & STORMFLOW SURVEY WATER QUALITY ANALYSES (JANUARY - DECEMBER)																			
STATION	DATE	TIME	SURVEY TYPE	FECAL	TOTAL	TOTAL KJELDAHL	OXIDIZED	TOTAL	ORTHOPHOSPHATE	TOTAL ORGANIC	TOTAL SUSPENDED	TURBIDITY (ntu)	LEAD (mg/L)	ZINC (mg/L)	REMARKS				
				CONDUCTIVITY (micro-mhos/cm)	COLIFORM (Colonies / 100 mL)	NITROGEN* (mg/L)	NITROGEN (mg/L)	PHOSPHORUS (mg/L)	CARBON (mg/L)	SOLIDS (mg/L)									
14	04/05/05	10:10	Baseflow	6.56	99.5	67	1.12	0.37	0.75	0.008	< 0.005	2.0	2.97						
1	05/02/05	14:00	Storm	6.45	93.3	649	0.25	0.23	0.02	0.036	0.013	129	12.3		0.87 Inches Rain				
2	05/02/05	10:45	Storm	6.77	103	727	0.36	0.28	0.08	0.135	0.012	30.0	41.4		0.87 Inches Rain				
3-I	05/02/05	13:25	Storm	6.60	133	219	0.25	0.25	< 0.01	0.021	0.009	75.5	5.52		0.87 Inches Rain				
3-II	05/02/05	13:45	Storm	7.22	190	326	0.27	0.27	< 0.01	0.023	0.011	114	7.18		0.87 Inches Rain				
4	05/02/05	13:10	Storm	6.69	90.7	125	0.26	0.24	0.02	0.019	0.010	85.5	10.6		0.87 Inches Rain				
5	05/02/05	12:45	Storm	6.94	77.5	291	0.29	0.29	< 0.01	0.039	0.015	116	9.98		0.87 Inches Rain				
6	05/02/05	12:25	Storm	6.40	48.1	313	0.34	0.25	0.09	0.018	0.009	220	8.64		0.87 Inches Rain				
7	05/02/05	12:00	Storm	6.48	47.4	179	0.30	0.25	0.05	0.080	0.014	521	16.5		0.87 Inches Rain				
8	05/02/05	14:15	Storm	6.61	56.9	96	0.31	0.31	< 0.01	0.037	0.008	24.5	8.50		0.87 Inches Rain				
13	05/02/05	11:40	Storm	6.90	93.2	548	0.56	0.36	0.20	0.014	0.008	102	5.21		0.87 Inches Rain				
14	05/02/05	11:15	Storm	7.28	60.5	219	0.88	0.37	0.51	0.015	0.010	215	2.24		0.87 Inches Rain				
1	05/05/05	12:55	Baseflow	6.90	103	75	0.41	0.39	0.02	0.022	0.009	5.52	4.8		5.79 < 0.0025 < 0.05				
2	05/05/05	10:05	Baseflow	6.53	101	194	0.48	0.40	0.08	0.020	0.010	4.84	6.8		8.07 < 0.0025 < 0.05				
3-I	05/05/05	12:30	Baseflow	6.60	51.7	46	0.44	0.43	0.01	0.019	0.010	7.14	2.8		4.57 < 0.0025 < 0.05				
3-II	05/05/05	12:40	Baseflow	6.88	57.4	79	0.43	0.42	0.01	0.019	0.011	6.55	7.8		6.59 < 0.0025 < 0.05				
4	05/05/05	12:00	Baseflow	6.34	54.6	119	0.47	0.43	0.04	0.015	0.010	5.85	4.8		6.20 < 0.0025 < 0.05				
5	05/05/05	11:35	Baseflow	7.00	81.3	61	0.45	0.44	0.01	0.029	0.017	5.70	4.6		8.35 < 0.0025 < 0.05				
6	05/05/05	11:15	Baseflow	6.79	77.2	28	0.58	0.46	0.12	0.010	0.007	3.35	5.4		12.24 < 0.0025 < 0.05				
7	05/05/05	11:00	Baseflow	7.11	136	63	0.53	0.43	0.10	0.018	0.008	3.18	6.2		15.49 < 0.0025 < 0.05				
8	05/05/05	13:00	Baseflow	7.10	61.8	126	0.78	0.44	0.34	0.033	0.008	5.98	12		19.95 < 0.0025 < 0.05				
13	05/05/05	10:45	Baseflow	6.69	137	291	0.70	0.45	0.25	0.011	0.008	2.42	6.8		5.54 < 0.0025 < 0.05				
14	05/05/05	10:30	Baseflow	6.75	102	145	0.76	0.46	0.30	0.012	0.010	1.98	3.8		2.98 < 0.0025 < 0.05				
1	06/01/05	14:00	Baseflow	6.91	135	63	0.39	0.30	0.09	**	0.006	11	6.06						
2	06/01/05	11:00	Baseflow	6.41	108	161	0.49	0.33	0.16	**	0.007	16	12.0						
3-I	06/01/05	13:30	Baseflow	6.46	57.4	112	0.32	0.31	0.01	**	0.006	6.0	5.66						
3-II	06/01/05	13:45	Baseflow	6.38	63.7	81	0.36	0.32	0.04	**	0.012	5.0	7.66						
4	06/01/05	13:15	Baseflow	5.90	70.0	1120	1.04	0.23	0.81	**	0.005	2.0	5.24						
5	06/01/05	13:05	Baseflow	6.94	92.1	86	0.35	0.27	0.08	**	0.030	8.0	13.6						
6	06/01/05	12:35	Baseflow	6.55	79.2	102	0.41	0.29	0.12	**	< 0.005	6.6	7.67						
7	06/01/05	12:10	Baseflow	6.94	151	219	0.41	0.29	0.12	**	< 0.005	11	6.94						
8	06/01/05	14:15	Baseflow	7.49	65.0	24	0.37	0.37	< 0.01	**	< 0.005	9.2	5.51						
13	06/01/05	11:30	Baseflow	6.52	134	770	0.43	0.36	0.07	**	0.008	2.2	4.68						
14	06/01/05	11:15	Baseflow	6.75	108	140	0.72	0.40	0.32	**	0.007	< 2	0.845						
1	07/05/05	10:50	Baseflow	6.95	179	82	0.45	0.34	0.11	0.018	0.008	12.6	8.12						
2	07/05/05	11:05	Baseflow	6.53	150	291	0.43	0.42	0.01	0.075	0.048	12.8	13.3						
3-I	07/05/05	11:45	Baseflow	6.38	85.6	11	0.31	0.31	< 0.01	0.075	0.031	4.40	9.35						
3-II	07/05/05	11:30	Baseflow	6.32	78.5	1	0.29	0.29	< 0.01	0.078	0.029	5.40	13.1						
4	07/05/05	11:50	Baseflow	5.63	119	33	0.24	0.23	0.01	0.006	< 0.005	3.40	1.78						
5	07/05/05	12:00	Baseflow	6.88	128	141	0.45	0.27	0.18	0.046	0.015	2.00	12.2						
6	07/05/05	12:10	Baseflow	6.67	164	23	0.34	0.34	< 0.01	0.121	0.096	35.0	36.2						
7	07/05/05	12:20	Baseflow	6.67	164	82</td													

RESULTS OF 2005 BASEFLOW & STORMFLOW SURVEY WATER QUALITY ANALYSES (JANUARY - DECEMBER)																			
STATION	DATE	TIME	SURVEY TYPE	FECAL	TOTAL	TOTAL KJELDAHL	OXIDIZED	TOTAL	ORTHOPHOSPHATE	TOTAL ORGANIC	TOTAL SUSPENDED	TURBIDITY	LEAD	ZINC	REMARKS				
				CONDUCTIVITY	COLIFORM	NITROGEN*	NITROGEN	PHOSPHORUS	CARBON	SOLIDS									
pH	(micro-mhos/cm)	(Colonies / 100 mL)	(mg/L)	(mg/L)	(mg/L)	(mg/L)	(mg/L)	(mg/L)	(mg/L)	(mg/L)	(mg/L)	(ntu)	(mg/L)	(mg/L)					
2	10/26/05	10:20	Stormflow	6.42	128	>2419	1.60	0.77	0.83	0.170	0.030	87.0	62.05		1.26	7			
3-II	10/26/05	10:45	Stormflow	6.29	100	1733	0.39	0.38	0.01	0.070	0.013	19.0	11.45		1.26	7			
4	10/26/05	11:00	Stormflow	6.40	46.1	>2419	0.93	0.69	0.24	0.200	0.040	46.0	27.85		1.26	7			
5	10/26/05	11:10	Stormflow	6.15	99.3	1733	0.65	0.60	0.05	0.090	0.017	36.0	10.05		1.26	7			
6	10/26/05	11:20	Stormflow	6.54	142	>2419	0.61	0.39	0.22	0.040	0.007	11.0	12.25		1.26	7			
7	10/26/05	11:30	Stormflow	6.82	232	2419	1.10	0.78	0.32	0.120	0.101	49.0	43.70		1.26	7			
8	10/26/05	10:00	Stormflow	6.68	59.2	231	1.22	1.20	0.02	0.120	0.006	6.00	11.90		1.26	7			
13	10/26/05	11:45	Stormflow	6.09	62.6	>2419	0.95	0.28	0.67	0.060	0.024	6.00	26.20		1.26	7			
14	10/26/05	10:30	Stormflow	6.52	92.5	>2419	2.32	0.49	1.83	0.060	0.031	3.00	10.75		1.26	7			
1	11/01/05	10:40	Baseflow	6.84	194	91	0.50	0.46	0.04	0.030	0.006	5.22	< 2.00	4.61	< 0.0025	< 0.05			
4	11/01/05	11:40	Baseflow	5.82	184	23	0.47	0.45	0.02	0.030	0.024	3.24	3.50	7.35	< 0.0025	< 0.05			
5	11/01/05	11:50	Baseflow	6.29	96.1	53	0.43	0.41	0.02	0.020	0.014	4.32	2.00	4.15	< 0.0025	< 0.05			
6	11/01/05	12:05	Baseflow	6.26	132	70	0.46	0.34	0.12	< 0.005	< 0.005	3.54	3.00	3.31	< 0.0025	< 0.05			
14	11/01/05	11:10	Baseflow	6.54	120	36	0.61	0.15	0.46	< 0.005	0.009	1.46	< 2.00	1.00	< 0.0025	< 0.05			
7	11/03/05	13:00	Baseflow	6.67	129.8	59		0.53	**	0.030	**	3.81	12.0	42.00	< 0.0025	< 0.05			
1	11/28/05	13:20	Stormflow	6.79	182	>2419	1.28	1.12	0.16	0.080	0.016	11.7	50.0	26.10	< 0.0025	< 0.05	1.74	8	
2	11/28/05	10:00	Stormflow	6.33	115	2419	0.53	0.50	0.03	0.080	0.027	10.1	9.33	14.30	< 0.0025	< 0.05	1.74	8	
3-II	11/28/05	12:50	Stormflow	6.25	100	194	0.72	0.43	0.29	0.090	0.038	13.1	43.3	21.15	< 0.0025	< 0.05	1.74	8	
4	11/28/05	12:35	Stormflow	5.92	127	>2419	0.71	0.61	0.10	0.090	0.061	8.58	28.7	10.20	< 0.0025	< 0.05	1.74	8	
5	11/28/05	12:15	Stormflow	6.51	107	579	0.58	0.57	0.01	0.050	**	10.3	2.67	5.00	< 0.0025	< 0.05	1.74	8	
6	11/28/05	12:05	Stormflow	6.29	109	34	0.73	0.71	0.02	0.050	0.028	11.6	55.3	4.10	< 0.0025	< 0.05	1.74	8	
7	11/28/05	11:45	Stormflow	6.76	159	>2419	0.68	0.48	0.20	0.080	0.015	7.26	54.7	38.05	< 0.0025	< 0.05	1.74	8	
8	11/28/05	13:40	Stormflow	6.74	55.6	24	0.94	0.91	0.03	0.080	0.019	5.64	12.0	5.10	< 0.0025	< 0.05	1.74	8	
13	11/28/05	11:30	Stormflow	6.00	60.1	>2419	1.00	0.99	0.01	0.140	0.036	11.1	133	11.85	< 0.0025	< 0.05	1.74	8	
14	11/28/05	11:00	Stormflow	6.34	50.6	>2419	1.39	1.01	0.38	0.200	0.049	5.57	72.0	7.90	< 0.0025	< 0.05	1.74	8	
1	12/01/05	12:20	Stormflow	6.59	140	55	1.30	1.15	0.15	0.090	0.009	27.0	22.10		0.860	9			
2	12/01/05	09:30	Stormflow	6.37	123	260	0.88	0.58	0.30	0.150	0.029	41.0	67.85		0.860	9			
3-I	12/01/05	11:40	Stormflow	5.76	31.7	866	0.56	0.49	0.07	0.030	0.008		< 2.00	3.90		0.860	9		
3-II	12/01/05	12:00	Stormflow	6.01	79.2	167	0.50	0.48	0.02	0.050	0.015		4.00	9.00		0.860	9		
4	12/01/05	11:25	Stormflow	5.87	108	86	0.52	0.48	0.04	0.090	0.017		38.5	17.90		0.860	9		
5	12/01/05	11:00	Stormflow	6.22	77.6	192	0.60	0.59	0.01	0.050	0.012		< 2.00	5.95		0.860	9		
6	12/01/05	10:40	Stormflow	6.25	104	47	0.62	0.43	0.19	0.040	0.009		6.00	12.45		0.860	9		
7	12/01/05	10:25	Stormflow	6.66	157	74	0.62	0.48	0.14	0.140	0.017		95.5	61.20		0.860	9		
8	12/01/05	09:15	Stormflow	6.33	53.9	8	0.83	0.78	0.05	0.070	< 0.005		15.5	6.40		0.860	9		
13	12/01/05	10:05	Stormflow	6.18	140	167	1.49	0.90	0.59	0.150	0.015		198	27.90		0.860	9		
14	12/01/05	09:45	Stormflow	6.56	102	167	1.57	0.35	1.22	0.080	0.005		50.5	2.20		0.860	9		
1	12/01/05	12:30	Baseflow	6.20	62.0	548	0.81	0.69	0.12	0.050	0.008		5.00	11.98					
2	12/01/05	09:40	Baseflow	4.52	44.0	249	1.01	0.76	0.25	0.060	0.017		12.0	41.80					
3-I	12/01/05	11:50	Baseflow	5.60	43.0	157	0.77	0.69	0.08	0.020	0.005		< 2.00	2.90					

RESULTS OF 2005 BASEFLOW & STORMFLOW SURVEY WATER QUALITY ANALYSES (JANUARY - DECEMBER)																
STATION	DATE	TIME	SURVEY TYPE	FECAL	TOTAL	TOTAL KJELDAHL	OXIDIZED	TOTAL	ORTHOPHOSPHATE	TOTAL ORGANIC	TOTAL SUSPENDED	TURBIDITY (ntu)	LEAD (mg/L)	ZINC (mg/L)	REMARKS	
				CONDUCTIVITY (micro-mhos/cm)	COLIFORM (Colonies / 100 mL)	NITROGEN*	NITROGEN	PHOSPHORUS (mg/L)	PHOSPHORUS (mg/L)	CARBON (mg/L)	SOLIDS (mg/L)					
7	12/27/05	11:15	Stormflow	6.77	24.4	93	0.57	0.43	0.14	0.260	0.108	45.5	73.90		0.810	12
8	12/27/05	12:45	Stormflow	6.34	53.0	70	0.45	0.38	0.07	0.040	**	7.00	9.18		0.810	12
13	12/27/05	11:00	Stormflow	6.29	111	>2419	0.62	0.38	0.24	0.020	**	< 2.00	4.25		0.810	12
14	12/27/05	10:40	Stormflow	6.37	97.0	52	0.76	0.42	0.34	0.040	**	22.5	4.55		0.810	12

hb High TDP blank of 0.003 mg/L, should be less than 0.0025 mg/L.

\* Total nitrogen is calculated as the sum of total kjeldahl nitrogen and total oxidized nitrogen.

\*\* Data excluded due to analytical error.

\*\*\* Orthophosphate measured greater than total phosphorus, however within analytical methods error.

## **Appendix B: Reservoir Water Quality Data by Date**

CHESTERFIELD COUNTY UTILITIES DEPARTMENT																											
ADDISON-EVANS WATER PRODUCTION FACILITY																											
RESULTS OF 2005 RESERVOIR SURVEY WATER QUALITY ANALYSES (JANUARY - DECEMBER)																											
STATION	DATE	TIME	DEPTH	DEPTH TXT	TEMPERATURE (Feet)	OXYGEN (Degrees Celsius)	DISSOLVED OXYGEN (% Saturation)	DISSOLVED OXYGEN (mg/L)	pH	ORP (Volts)	CONDUCTIVITY (micro-mhos/cm)	SECCHI DISK (Feet)	FECAL COLIFORM (Colonies/100mL)	CHLOROPHYLL a (ppb)	PHEOPHYTIN a (ppb)	TOTAL NITROGEN* (mg/L)	TOTAL NITROGEN (mg/L)	TOTAL KJELDAHL NITROGEN (mg/L)	OXIDIZED NITROGEN (mg/L)	AMMONIA NITROGEN (mg/L)	TOTAL PHOSPHORUS (mg/L)	ORTHOPHOSPHATE PHOSPHORUS (mg/L)	TOTAL ORGANIC CARBON (mg/L)	SUSPENDED SOLIDS (mg/L)	TURBIDITY (ntu)	LEAD (mg/L)	ZINC (mg/L)
1	01/12/05	11:17	Surface	0.1	9.7	87.5	10.14	6.70	0.721	43.0	3.5	6	1.9	0.1	0.28	0.28	< 0.01	< 0.03	0.023	0.006	4.20	4.4	6.62	< 0.025	< 0.05		
1	01/12/05	11:14	Mid-depth	3.0	9.7	87.5	10.10	6.68	0.722	44.1																	
1	01/12/05	11:11	Mid-depth	6.0	9.3	87.3	10.08	6.67	0.724	45.4																	
1	01/12/05	11:08	Bottom	9.0	9.2	88.9	10.24	6.62	0.726	47.1																	
2	01/12/05	11:28	Surface	0.1	10.2	87.2	10.07	6.73	0.697	39.7	3.8	1	2.4	0.1	0.28	0.28	< 0.01	< 0.03	0.021	0.008	4.66	4.2	5.66	< 0.025	< 0.05		
2	01/12/05	11:25	Mid-depth	3.0	10.1	91.5	10.35	6.73	0.693	37.8																	
2	01/12/05	11:22	Bottom	6.0	10.2	90.6	10.26	6.68	0.693	38.2																	
3	01/12/05	11:50	Surface	0.1	10.0	95.3	10.85	6.97	0.681	45.9	3.0	46	6.0	0.1	0.32	0.32	< 0.01	< 0.03	0.015	< 0.005	3.84	6.2	7.80	< 0.025	< 0.05		
3	01/12/05	11:47	Mid-depth	3.0	9.9	95.2	10.81	6.95	0.680	46.2																	
3	01/12/05	11:44	Mid-depth	6.0	9.8	95.3	10.86	6.95	0.680	47.0																	
3	01/12/05	11:41	Mid-depth	9.0	9.7	99.1	11.34	6.94	0.682	47.2																	
3	01/12/05	11:38	Bottom	12.0	9.7	103	11.77	9.64	0.681	47.3																	
4	01/12/05	12:07	Surface	0.1	9.5	99.2	11.38	7.00	0.672	32.2	3.5	140	11.0	0.2	0.31	0.31	< 0.01	< 0.03	0.017	< 0.005	6.55	3.2	4.44	< 0.025	< 0.05		
4	01/12/05	12:04	Mid-depth	1.0	9.5	97.5	11.28	6.99	0.673	32.3																	
4	01/12/05	12:01	Mid-depth	4.0	9.5	97.4	11.28	7.02	0.671	32.1																	
4	01/12/05	11:58	Mid-depth	7.0	9.4	98.4	11.36	7.08	0.671	32.9																	
4	01/12/05	11:55	Bottom	10.0	9.4	99.3	11.40	7.11	0.673	33.4																	
5	01/12/05	12:30	Surface	0.1	9.2	96.1	11.13	6.92	0.671	31.8	3.7	1203	13.1	0.2	0.31	0.31	< 0.01	< 0.03	0.017	< 0.005	6.58	5.0	5.42	< 0.025	< 0.05		
5	01/12/05	12:27	Mid-depth	2.0	8.8	94.3	11.02	6.73	0.667	31.9																	
5	01/12/05	12:24	Mid-depth	5.0	8.9	96.0	11.41	6.86	0.670	31.6																	
5	01/12/05	12:18	Mid-depth	8.0	8.9	95.5	11.18	6.82	0.669	31.5																	
5	01/12/05	12:15	Mid-depth	11.0	8.7	95.5	11.18	6.83	0.670	31.5																	
5	01/12/05	12:15	Mid-depth	14.0	8.6	91.7	10.80	6.87	0.669	32.1																	
5	01/12/05	12:12	Bottom	17.0	8.5	93.0	10.85	6.89	0.670	32.2																	
6	01/12/05	12:53	Surface	0.1	9.0	94.5	11.03	6.82	0.670	32.0	3.6	24	11.6	0.2	0.31	0.31	< 0.01	< 0.03	0.017	< 0.005	6.75	3.8	5.37	< 0.025	< 0.05		
6	01/12/05	12:50	Mid-depth	2.0	8.9	94.5	11.04	6.86	0.665	32.1																	
6	01/12/05	12:47	Mid-depth	5.0	8.8	94.3	11.00	6.73	0.667	31.9																	
6	01/12/05	12:44	Mid-depth	8.0	8.7	93.3	10.94	6.73	0.667	31.8																	
6	01/12/05	12:41	Mid-depth	11.0	8.4	90.7	10.68	6.63	0.669	31.6																	
6	01/12/05	12:38	Mid-depth	14.0	8.3	88.9	10.51	6.67	0.668	31.6																	
6	01/12/05	12:35	Bottom	17.0	8.3	88.3	10.49	6.75	0.667	31.6																	
7	01/12/05	13:10	Surface	0.1	9.3	95.8	11.10	6.72	0.664	32.3	3.5	7	7.9	0.1	0.31	0.31	< 0.01	< 0.03	0.015	< 0.005	6.71	4.0	5.24	< 0.025	< 0.05		
7	01/12/05	13:07	Mid-depth	1.0	9.2	93.7	10.82	6.73	0.667	32.2																	
7	01/12/05	13:04	Mid-depth	4.0	9.1	91.7	10.71	6.80	0.659	32.2																	
7	01/12/05	13:01	Mid-depth	7.0	9.0	92.4	10.74	6.77	0.660	32.2																	
7	01/12/05	12:58	Bottom	10.0	8.7	88.4	10.34	6.82	0.659	32.0																	
8	01/12/05	13:39	Surface	0.1	9.1	96.2	11.16	6.87	0.659	32.3	3.6	15	16.2	0.2	0.32	0.32	< 0.01	< 0.03	0.018	< 0.005	6.79	2.6	4.84	< 0.025	< 0.05		
8	01/12/05	13:36	Mid-depth	2.0	9.1	96.2	11.15	6.84	0.654	32.4																	
8	01/12/05	13:33	Mid-depth	5.0	8.7	93.7	10.96	6.77	0.654	31.9																	
8	01/12/05	13:30	Mid-depth	8.0	8.3	90.7	10.79	6.69	0.655	31.6																	
8	01/12/05	13:27	Mid-depth	11.0	8.2	86.3	10.24	6.59	0.657	31.4																	
8	01/12/05	13:24	Mid-depth	14.0	7.9	82.5	9.86	6.44	0.658	31.4																	
8	01/12/05	13:21	Mid-depth	17.0	7.7	75.2	9.03	6.41	0.660	31.5																	
8	01/12/05	13:18	Mid-depth	20.0	7.6	75.1	9.03	6.56	0.656	31.8																	
8	01/12/05	13:15	Bottom	23.0	7.5	74.4	8.95	6.52	0.654	31.8																	
5	01/26/05	13:00	Surface	0.1	2.7	92.1	12.35	6.65	0.672	30.9																	

\* Total nitrogen is calculated as the sum of total kjeldahl nitrogen and total oxidized nitrogen.

\*\* Data excluded due to analytical error.

\*\*\* Orthophosphate measured greater than total phosphorus, however within analytical methods error.

CHESTERFIELD COUNTY UTILITIES DEPARTMENT																									
ADDISON-EVANS WATER PRODUCTION FACILITY																									
RESULTS OF 2005 RESERVOIR SURVEY WATER QUALITY ANALYSES (JANUARY - DECEMBER)																									
STATION	DATE	TIME	DEPTH TXT	DEPTH (Feet)	TEMPERATURE (Degrees Celsius)	DISSOLVED OXYGEN (% Saturation)	DISSOLVED OXYGEN (mg/L)	pH	ORP (Volts)	CONDUCTIVITY (micro-mhos/cm)	SECCHI DISK (Feet)	FECAL COLIFORM (Colonies/100mL)	CHLOROPHYLL a (ppb)	PHEOPHYTIN a (ppb)	TOTAL NITROGEN* (mg/L)	TOTAL KJELDAHL NITROGEN (mg/L)	OXIDIZED NITROGEN (mg/L)	AMMONIA NITROGEN (mg/L)	TOTAL PHOSPHORUS (mg/L)	ORTHOPHOSPHATE PHOSPHORUS (mg/L)	ORGANIC CARBON (mg/L)	SUSPENDED SOLIDS (mg/L)	TOTAL TURBIDITY (ntu)	LEAD (mg/L)	ZINC (mg/L)
4	02/16/05	14:17	Mid-depth	1.0	8.1	105	12.32	7.24	***	56.2															
4	02/16/05	14:14	Mid-depth	4.0	8.0	106	12.41	7.22	***	56.4															
4	02/16/05	14:11	Mid-depth	7.0	7.7	107	12.46	7.19	***	56.4															
4	02/16/05	14:08	Bottom	10.0	7.5	107	12.50	7.18	***	55.7															
5	02/16/05	14:05	Surface	0.1	6.7	98.0	11.80	7.15	***	54.8	3.4	579	13.1	0.2	0.32	0.32	< 0.01	< 0.03	0.022	< 0.005	6.18	5.4	7.88	< 0.0025	< 0.05
5	02/16/05	14:00	Mid-depth	2.0	6.8	102	11.75	7.08	***	55.5															
5	02/16/05	13:57	Mid-depth	5.0	6.6	97.7	11.75	7.09	***	54.9															
5	02/16/05	13:54	Mid-depth	8.0	6.6	97.4	11.72	7.07	***	54.8					0.32	0.32	< 0.01	< 0.03	0.020	< 0.005					
5	02/16/05	13:51	Mid-depth	11.0	6.6	97.0	11.65	7.05	***	54.9															
5	02/16/05	13:48	Mid-depth	14.0	6.6	97.9	11.79	7.03	***	54.8															
5	02/16/05	13:45	Bottom	17.0	6.5	97.9	11.79	7.00	***	54.8					0.34	0.34	< 0.01	< 0.03	0.029	< 0.005					
6	02/16/05	13:42	Surface	0.1	7.2	100	12.03	7.08	***	55.0	3.3	15	4.3	0.1	0.31	0.31	< 0.01	< 0.03	0.019	< 0.005	4.51	5.6	7.22	< 0.0025	< 0.05
6	02/16/05	13:32	Mid-depth	1.0	7.0	101	12.08	7.07	***	55.2															
6	02/16/05	13:29	Mid-depth	4.0	6.8	102	12.17	7.08	***	55.5															
6	02/16/05	13:26	Mid-depth	7.0	6.6	102	12.30	7.05	***	55.5															
6	02/16/05	13:23	Mid-depth	10.0	6.5	103	12.33	7.02	***	55.4															
6	02/16/05	13:20	Mid-depth	13.0	6.4	104	12.50	6.94	***	55.3															
6	02/16/05	13:17	Bottom	16.0	6.4	104	12.45	6.89	***	54.9															
7	02/16/05	13:14	Surface	0.1	7.0	102	12.18	7.07	***	56.3	3.1	11	9.1	0.1	0.32	0.32	< 0.01	< 0.03	0.018	< 0.005	4.66	5.0	6.90	< 0.0025	< 0.05
7	02/16/05	13:09	Mid-depth	1.0	6.7	104	12.30	7.03	***	56.3															
7	02/16/05	13:06	Mid-depth	4.0	7.0	104	12.35	7.00	***	56.1															
7	02/16/05	13:03	Mid-depth	7.0	6.6	104	12.40	6.98	***	56.1															
7	02/16/05	13:00	Bottom	10.0	6.5	104	12.30	6.95	***	56.2															
8	02/16/05	12:57	Surface	0.1	7.3	103	12.13	6.99	***	54.1	3.5	11	9.6	0.1	0.32	0.32	< 0.01	< 0.03	0.020	< 0.005	4.57	4.4	8.08	< 0.0025	< 0.05
8	02/16/05	12:49	Mid-depth	2.0	7.2	102	12.10	6.97	***	54.0															
8	02/16/05	12:46	Mid-depth	5.0	7.1	100	11.96	6.93	***	54.0															
8	02/16/05	12:43	Mid-depth	8.0	6.9	98.2	11.88	6.85	***	54.0															
8	02/16/05	12:40	Mid-depth	11.0	6.6	96.0	11.72	6.77	***	53.8					0.33	0.33	< 0.01	< 0.03	0.019	< 0.005					
8	02/16/05	12:37	Mid-depth	14.0	6.1	94.7	11.66	6.60	***	53.5															
8	02/16/05	12:34	Mid-depth	17.0	6.1	94.6	11.60	6.47	***	53.3															
8	02/16/05	12:31	Mid-depth	20.0	***	***	***	***	***	***															
8	02/16/05	12:28	Bottom	23.0	***	***	***	***	***	***					0.34	0.34	< 0.01	< 0.03	0.020	< 0.005					
1	03/15/05	12:04	Surface	0.1	9.7	94.2	10.80	7.20	***	72.4	3.8	4	0.3	0.0	0.30	0.29	0.01	< 0.03	0.017	< 0.005	3.05	4.4	5.89	< 0.0025	< 0.05
1	03/15/05	12:01	Mid-depth	3.0	9.6	94.5	10.85	7.20	***	72.4															
1	03/15/05	11:58	Mid-depth	6.0	9.6	96.2	11.05	7.18	***	72.4															
1	03/15/05	11:55	Bottom	9.0	9.5	97.6	11.26	7.05	***	71.9															
2	03/15/05	12:18	Surface	0.1	9.5	94.8	10.91	7.39	***																

CHESTERFIELD COUNTY UTILITIES DEPARTMENT																									
ADDISON-EVANS WATER PRODUCTION FACILITY																									
RESULTS OF 2005 RESERVOIR SURVEY WATER QUALITY ANALYSES (JANUARY - DECEMBER)																									
STATION	DATE	TIME	DEPTH TXT	DEPTH (Feet)	TEMPERATURE (Degrees Celsius)	DISSOLVED OXYGEN (% Saturation)	DISSOLVED OXYGEN (mg/L)	pH	ORP (Volts)	CONDUCTIVITY (micro-mhos/cm)	SECCHI DISK (Feet)	FECAL COLIFORM (Colonies/100mL)	CHLOROPHYLL a (ppb)	PHEOPHYTIN a (ppb)	TOTAL NITROGEN* (mg/L)	TOTAL KJELDAHL NITROGEN (mg/L)	OXIDIZED NITROGEN (mg/L)	AMMONIA NITROGEN (mg/L)	TOTAL PHOSPHORUS (mg/L)	ORTHOPHOSPHATE PHOSPHORUS (mg/L)	ORGANIC CARBON (mg/L)	SUSPENDED SOLIDS (mg/L)	TOTAL TURBIDITY (ntu)	LEAD (mg/L)	ZINC (mg/L)
8	03/15/05	13:50	Mid-depth	20.0	7.3	85.8	10.43	7.23	****	67.0					0.31	0.31	< 0.01	< 0.03	0.018	< 0.005					
8	03/15/05	13:48	Bottom	23.0	7.2	85.5	10.41	7.27	****	67.2															
5	03/30/05	14:05	Surface	0.1	13.9	99.8	10.00	6.99	****	69.4	3.0		7.4	0.2	0.32	0.32	< 0.01	< 0.03	0.014	< 0.005	4.85	6.8	5.64	< 0.025	
5	03/30/05	14:02	Mid-depth	2.0	13.4	97.0	9.90	6.97	****	69.4															
5	03/30/05	13:59	Mid-depth	5.0	12.3	95.0	9.80	6.94	****	69.3															
5	03/30/05	13:56	Mid-depth	8.0	12.0	93.0	9.80	6.91	****	69.2															
5	03/30/05	13:53	Mid-depth	11.0	12.0	93.0	9.80	6.90	****	68.9															
5	03/30/05	13:50	Mid-depth	14.0	11.8	92.0	9.80	6.88	****	68.8															
5	03/30/05	13:47	Bottom	17.0	11.4	90.0	9.50	6.75	****	69.9															
8	03/30/05	14:35	Surface	0.1	14.4	116	11.00	6.90	****	70.3	3.5		5.2	0.1	0.31	0.31	< 0.01	< 0.03	0.015	< 0.005	5.27	5.4	4.08	< 0.025	
8	03/30/05	14:32	Mid-depth	2.0	13.7	112	11.00	6.81	****	69.0															
8	03/30/05	14:29	Mid-depth	5.0	12.4	106	10.80	6.78	****	67.3															
8	03/30/05	14:26	Mid-depth	8.0	11.7	101	10.80	6.77	****	67.1															
8	03/30/05	14:23	Mid-depth	11.0	11.5	102	10.40	6.73	****	67.0															
8	03/30/05	14:20	Mid-depth	14.0	11.5	101	10.30	6.70	****	66.8															
8	03/30/05	14:17	Mid-depth	17.0	11.4	105	10.20	6.62	****	66.7															
8	03/30/05	14:14	Mid-depth	20.0	11.1	104	10.20	6.55	****	66.5															
8	03/30/05	14:11	Bottom	23.0	10.9	100	10.00	6.48	****	66.4															
1	04/14/05	09:00	Surface	0.1	16.4	80.1	7.83	7.20	****	73.1	3.4	5	2.3	0.1	0.39	0.39	< 0.01	< 0.03	0.020	0.006		5.6	7.48		
1	04/14/05	09:02	Mid-depth	3.0	14.7	84.3	8.57	7.22	****	73.1															
1	04/14/05	09:04	Mid-depth	6.0	14.6	81.9	8.33	7.18	****	73.0															
1	04/14/05	09:06	Bottom	9.0	14.3	82.1	8.41	7.15	****	73.0															
2	04/14/05	09:10	Surface	0.1	14.9	86.9	8.78	7.18	****	69.0	3.5	4	3.0	0.1	0.40	0.40	< 0.01	< 0.03	0.022	< 0.005		5.8	7.16		
2	04/14/05	09:12	Mid-depth	3.0	14.8	85.7	8.68	7.11	****	61.9															
2	04/14/05	09:14	Bottom	6.0	14.7	87.0	8.84	7.05	****	60.9															
3	04/14/05	09:28	Surface	0.1	15.3	84.4	8.46	7.33	****	72.7	3.2	31	4.3	0.1	0.43	0.43	< 0.01	< 0.03	0.011	< 0.005		5.2	6.16		
3	04/14/05	09:30	Mid-depth	3.0	15.3	87.2	8.74	7.30	****	76.0															
3	04/14/05	09:32	Mid-depth	6.0	15.1	81.2	8.17	7.32	****	84.3															
3	04/14/05	09:34	Mid-depth	9.0	15.0	86.4	8.71	7.29	****	83.4															
3	04/14/05	09:36	Bottom	12.0	15.0	86.8	8.71	7.31	****	83.2															
4	04/14/05	09:42	Surface	0.1	15.4	88.9	8.90	7.28	****	70.0	3.5	26	7.2	0.0	0.42	0.42	< 0.01	< 0.03	0.013	< 0.005		6.2	5.86		
4	04/14/05	09:44	Mid-depth	1.0	15.4	88.6	8.87	7.20	****	69.9															
4	04/14/05	09:46	Mid-depth	4.0	15.3	88.7	8.89	7.20	****	69.8															
4	04/14/05	09:48	Mid-depth	7.0	15.3	89.2	8.93	7.12	****	70.4															
4	04/14/05	09:50	Bottom	10.0	15.3	88.7	8.89	7.17	****	69.7															
5	04/14/05	09:58	Surface	0.1	15.3	88.0	8.81	7.29	****	70.6	3.5	5	6.8	0.2	0.43	0.43	< 0.01	< 0.03	0.014	< 0.005		5.2	5.46		
5	04/14/05	10:00	Mid-depth	2.0	15.2	83.1	8.35	7.16	****	70.8															

CHESTERFIELD COUNTY UTILITIES DEPARTMENT																									
ADDISON-EVANS WATER PRODUCTION FACILITY																									
RESULTS OF 2005 RESERVOIR SURVEY WATER QUALITY ANALYSES (JANUARY - DECEMBER)																									
STATION	DATE	TIME	DEPTH TXT	DEPTH (Feet)	TEMPERATURE (Degrees Celsius)	DISSOLVED OXYGEN (% Saturation)	DISSOLVED OXYGEN (mg/L)	pH	ORP (Volts)	CONDUCTIVITY (micro-mhos/cm)	SECCHI DISK (Feet)	FECAL COLIFORM (Colonies/100mL)	CHLOROPHYLL a (ppb)	PHEOPHYTIN a (ppb)	TOTAL NITROGEN* (mg/L)	TOTAL KJELDAHL NITROGEN (mg/L)	OXIDIZED NITROGEN (mg/L)	AMMONIA NITROGEN (mg/L)	TOTAL PHOSPHORUS (mg/L)	ORTHOPHOSPHATE PHOSPHORUS (mg/L)	ORGANIC CARBON (mg/L)	SUSPENDED SOLIDS (mg/L)	TOTAL TURBIDITY (ntu)	LEAD (mg/L)	ZINC (mg/L)
8	04/29/05	12:05	Mid-depth	14.0	16.2	83.4	8.14	6.97	***	69.3															
8	04/29/05	12:07	Mid-depth	17.0	15.9	83.6	8.22	6.89	***	69.4															
8	04/29/05	12:09	Mid-depth	20.0	15.8	79.3	7.81	6.85	***	69.5															
8	04/28/05	12:11	Bottom	23.0	15.8	82.0	8.08	6.86	***	69.7						0.50	0.50	< 0.01	< 0.03	0.017	< 0.005				
1	05/11/05	09:30	Surface	0.1	21.2	108	9.64	7.67	***	84.1	6.0	2	1.1	<0.1	0.38	0.38	< 0.01	< 0.03	0.021	< 0.005	6.90	2.4	4.26	< 0.0025	< 0.05
1	05/11/05	09:33	Mid-depth	2.0	21.1	110	9.77	8.21	***	85.5															
1	05/11/05	09:36	Mid-depth	5.0	20.9	105	9.42	8.25	***	85.3															
1	05/11/05	09:39	Bottom	8.0	20.7	103	9.28	8.25	***	85.0															
2	05/11/05	09:44	Surface	0.1	21.7	103	9.06	7.24	***	79.6	5.5	1	1.0	<0.1	0.52	0.51	0.01	< 0.03	0.019	< 0.005	6.92	2.6	3.97	< 0.0025	< 0.05
2	05/11/05	09:47	Mid-depth	3.0	19.6	100	9.23	7.41	***	80.3															
2	05/11/05	09:50	Bottom	6.0	21.6	96.6	8.53	6.52	***	89.1															
3	05/11/05	10:00	Surface	0.1	21.6	91.1	8.04	6.84	***	89.3	4.2	5	3.2	0.1	0.47	0.46	0.01	< 0.03	0.013	< 0.005	5.64	5.2	5.26	< 0.0025	< 0.05
3	05/11/05	10:03	Mid-depth	3.0	21.5	92.0	8.13	7.09	***	92.3															
3	05/11/05	10:06	Mid-depth	6.0	21.1	97.9	8.73	7.35	***	96.5															
3	05/11/05	10:09	Mid-depth	9.0	20.9	101	9.09	7.59	***	103															
3	05/11/05	10:12	Bottom	12.0	20.1	104	9.50	8.11	***	108															
4	05/11/05	10:18	Surface	0.1	20.9	100	8.95	7.35	***	84.9	4.5	3	2.1	0.1	0.47	0.46	0.01	< 0.03	0.011	< 0.005	5.61	4.2	3.72	< 0.0025	< 0.05
4	05/11/05	10:21	Mid-depth	1.0	20.6	98.3	8.84	7.35	***	85.0															
4	05/11/05	10:24	Mid-depth	4.0	20.5	98.7	8.91	7.34	***	84.8															
4	05/11/05	10:27	Mid-depth	7.0	20.3	97.4	8.84	7.27	***	84.4															
4	05/11/05	10:30	Bottom	10.0	20.1	94.5	8.60	7.24	***	84.3															
5	05/11/05	10:37	Surface	0.1	22.1	100	8.75	6.85	***	84.5	4.4	1	3.3	0.1	0.49	0.49	< 0.01	< 0.03	0.011	< 0.005	5.53	3.6	3.96	< 0.0025	< 0.05
5	05/11/05	10:40	Mid-depth	1.0	21.1	95.9	8.56	7.14	***	84.0															
5	05/11/05	10:43	Mid-depth	4.0	20.3	96.4	8.76	7.19	***	84.1															
5	05/11/05	10:46	Mid-depth	7.0	20.0	99.0	8.94	7.21	***	84.1						0.48	0.47	0.01	< 0.03	0.010	< 0.005				
5	05/11/05	10:49	Mid-depth	10.0	19.7	94.4	8.67	7.21	***	84.2															
5	05/11/05	10:52	Mid-depth	13.0	19.4	95.5	8.82	7.23	***	83.6															
5	05/11/05	10:55	Bottom	16.0	17.9	88.0	8.37	7.12	***	83.6						0.47	0.46	0.01	0.03	0.011	< 0.005				
6	05/11/05	11:01	Surface	0.1	20.4	99.0	8.95	7.00	***	84.4	4.5	2	5.5	0.1	0.52	0.51	0.01	< 0.03	0.012	< 0.005	5.70	3.4	3.97	< 0.0025	< 0.05
6	05/11/05	11:04	Mid-depth	1.0	19.3	98.4	9.09	7.34	***	84.6															
6	05/11/05	11:07	Mid-depth	4.0	19.2	99.8	9.24	7.46	***	84.7															
6	05/11/05	11:10	Mid-depth	7.0	19.0	101	9.37	7.52	***	84.3															
6	05/11/05	11:13	Mid-depth	10.0	18.3	97.0	9.15	7.45	***	83.8															
6	05/11/05	11:16	Mid-depth	13.0	17.5	91.8	8.81	7.23	***	83.7															
6	05/11/05	11:19	Bottom	16.0	17.3	88.8	8.55	7.12	***	83.6															
7	05/11/05	11:24	Surface	0.1	20.4	103	9.27	7.65	***	84.4	4.6	3	6.1	0.1	0.29	0.									

\* Total nitrogen is calculated as the sum of total kjeldahl nitrogen and total oxidized nitrogen.

\*\* Data excluded due to analytical error.

\*\*\* Orthophosphate measured greater than total phosphorus, however within analytical methods error.

CHESTERFIELD COUNTY UTILITIES DEPARTMENT																									
ADDISON-EVANS WATER PRODUCTION FACILITY																									
RESULTS OF 2005 RESERVOIR SURVEY WATER QUALITY ANALYSES (JANUARY - DECEMBER)																									
STATION	DATE	TIME	DEPTH TXT	DEPTH (Feet)	TEMPERATURE (Degrees Celsius)	DISSOLVED OXYGEN (% Saturation)	DISSOLVED OXYGEN (mg/L)	pH	ORP (Volts)	CONDUCTIVITY (micro-mhos/cm)	SECCHI DISK (Feet)	FECAL COLIFORM (Colonies/100mL)	CHLOROPHYLL a (ppb)	PHEOPHYTIN a (ppb)	TOTAL NITROGEN* (mg/L)	TOTAL KJELDAHL NITROGEN (mg/L)	OXIDIZED NITROGEN (mg/L)	AMMONIA NITROGEN (mg/L)	TOTAL PHOSPHORUS (mg/L)	ORTHOPHOSPHATE PHOSPHORUS (mg/L)	ORGANIC CARBON (mg/L)	SUSPENDED SOLIDS (mg/L)	TOTAL TURBIDITY (ntu)	LEAD (mg/L)	ZINC (mg/L)
7	07/06/05	12:12	Mid-depth	6.0	28.0	65.2	5.09	6.49	0.534	79.2															
7	07/06/05	12:14	Bottom	9.0	27.0	9.90	0.79	6.33	0.490	81.1															
8	07/06/05	12:24	Surface	0.1	30.2	105	7.89	7.46	0.604	78.6	4.3	<1	1.2	0.1	0.55	0.55	< 0.01	0.04	0.015	0.006		< 2.00	1.92		
8	07/06/05	12:26	Mid-depth	1.0	29.7	104	7.87	7.42	0.596	78.7															
8	07/06/05	12:28	Mid-depth	4.0	29.3	102	7.80	7.33	0.594	78.4															
8	07/06/05	12:30	Mid-depth	7.0	29.1	102	7.84	7.34	0.586	78.2															
8	07/06/05	12:32	Mid-depth	10.0	29.1	102	7.84	7.35	0.582	78.4						0.67	0.67	< 0.01	0.04	0.021	0.006				
8	07/06/05	12:34	Mid-depth	13.0	27.6	40.1	3.16	6.35	0.620	78.6															
8	07/06/05	12:36	Mid-depth	16.0	24.0	3.30	0.28	6.32	0.302	88.0															
8	07/06/05	12:38	Mid-depth	19.0	19.7	2.10	< 0.20	6.71	0.154	124															
8	07/06/05	12:40	Bottom	22.0	18.1	1.80	< 0.20	7.11	0.083	156						0.82	0.82	< 0.01	0.04	0.013	0.008				
5	07/18/05	10:52	Surface	0.1	31.1	105	7.78	7.45	0.634	75.9	4.9		2.8	0.1	0.54	0.54	< 0.01	< 0.03	0.095	< 0.05		2.40	3.20		
5	07/18/05	10:54	Mid-depth	2.0	31.0	104	7.72	7.45	0.491	75.9															
5	07/18/05	10:56	Mid-depth	5.0	30.9	103	7.65	7.42	0.496	75.8															
5	07/18/05	10:58	Mid-depth	8.0	30.5	95.1	7.12	7.15	0.509	75.4						0.56	0.56	< 0.01	< 0.03	0.095	< 0.05				
5	07/18/05	11:00	Mid-depth	11.0	27.8	17.2	1.35	6.29	0.539	78.5															
5	07/18/05	11:02	Mid-depth	14.0	23.9	1.50	< 0.20	6.68	0.214	107															
5	07/18/05	11:04	Bottom	17.0	22.9	1.60	< 0.20	6.86	0.150	123						0.80	0.80	< 0.01	0.23	0.105	< 0.05				
8	07/18/05	11:10	Surface	0.1	32.2	109	7.91	7.56	0.455	75.9	4.9		4.2	0.1	0.54	0.54	< 0.01	< 0.03	0.084	< 0.05		2.60	2.90		
8	07/18/05	11:12	Mid-depth	2.0	31.4	107	7.92	7.45	0.404	75.6															
8	07/18/05	11:14	Mid-depth	5.0	31.0	107	7.93	7.46	0.419	75.6															
8	07/18/05	11:16	Mid-depth	8.0	30.2	98.0	7.37	7.09	0.435	75.1															
8	07/18/05	11:18	Mid-depth	11.0	28.2	34.3	2.67	6.27	0.460	76.2						0.78	0.78	< 0.01	0.03	0.088	< 0.05				
8	07/18/05	11:20	Mid-depth	14.0	26.4	5.00	0.40	6.23	0.457	81.2															
8	07/18/05	11:22	Mid-depth	17.0	22.2	2.20	< 0.20	6.69	0.207	119															
8	07/18/05	11:24	Mid-depth	20.0	19.5	2.10	< 0.20	6.93	0.090	151															
8	07/18/05	11:26	Bottom	23.0	19.4	1.30	< 0.20	7.07	0.028	156						0.75	0.75	< 0.01	0.19	0.105	< 0.05				
5	08/03/05	09:30	Surface	0.1	29.9	107	8.07	7.54	0.658	78.1	4.1		3.2	0.1	0.51	0.51	**	< 0.03	0.013hb	< 0.005		2.20	2.65		
5	08/03/05	09:32	Mid-depth	1.0	29.9	106	8.05	7.57	0.416	77.9															
5	08/03/05	09:34	Mid-depth	4.0	29.7	106	8.00	7.44	0.458	77.8															
5	08/03/05	09:36	Mid-depth	7.0	29.0	82.0	6.29	6.78	0.494	77.7						0.52	0.52	**	< 0.03	0.013hb	< 0.005				
5	08/03/05	09:38	Mid-depth	10.0	28.4	63.2	4.90	6.60	0.505	78.2															
5	08/03/05	09:40	Mid-depth	13.0	27.8	13.1	1.03	6.43	0.501	84.1															
5	08/03/05	09:42	Bottom	16.0	23.3	1.90	< 0.20	7.01	0.195	147						0.71	0.71	**	0.04	0.019hb	< 0.005				
8	08/03/05	09:50	Surface	0.1	30.4	109	8.19	7.60	0.430	77.8	4.7		2.0	0.1	0.55	0.55	**	< 0.03	0.013hb	< 0.005		3.00	2.09		
8	08/03/05	09:52	Mid-depth																						

CHESTERFIELD COUNTY UTILITIES DEPARTMENT																									
ADDISON-EVANS WATER PRODUCTION FACILITY																									
RESULTS OF 2005 RESERVOIR SURVEY WATER QUALITY ANALYSES (JANUARY - DECEMBER)																									
STATION	DATE	TIME	DEPTH TXT	DEPTH (Feet)	TEMPERATURE (Degrees Celsius)	DISSOLVED OXYGEN (% Saturation)	DISSOLVED OXYGEN (mg/L)	pH	ORP (Volts)	CONDUCTIVITY (micro-mhos/cm)	SECCHI DISK (Feet)	FECAL COLIFORM (Colonies/100mL)	CHLOROPHYLL a (ppb)	PHEOPHYTIN a (ppb)	TOTAL NITROGEN* (mg/L)	TOTAL KJELDAHL NITROGEN (mg/L)	OXIDIZED NITROGEN (mg/L)	AMMONIA NITROGEN (mg/L)	TOTAL PHOSPHORUS (mg/L)	ORTHOPHOSPHATE PHOSPHORUS (mg/L)	ORGANIC CARBON (mg/L)	SUSPENDED SOLIDS (mg/L)	TOTAL TURBIDITY (ntu)	LEAD (mg/L)	ZINC (mg/L)
8	08/19/05	10:52	Mid-depth	17.0	21.8	1.50	< 0.20	6.86	0.244	154					0.83	0.83	< 0.01	1.06Er	0.010hb	0.012					
8	08/19/05	10:55	Mid-depth	20.0	20.4	1.40	< 0.20	7.09	0.093	178															
8	08/18/05	10:58	Bottom	23.0	20.6	1.40	< 0.20	7.09	0.091	179					0.83	0.83	< 0.01	1.06Er	0.010hb	0.012					
3	08/22/05	09:00	Surface	0.1							9														
4	08/22/05	08:45	Surface	0.1							<1														
5	08/22/05	08:30	Surface	0.1							3														
3	09/06/05	10:26	Surface	0.1	25.3	76.8	6.37	6.73	0.450	87.1	1.2	7	18.2	0.4	0.45	0.45	<0.01	0.04	0.051	< 0.005		20.8	16.98		
3	09/06/05	10:29	Middle	1.0	25.2	76.9	6.40	6.69	0.490	89.1															
3	09/06/05	10:32	Middle	4.0	24.6	73.5	6.19	6.61	0.514	92.6															
3	09/06/05	10:35	Bottom	7.0	24.5	7.30	0.62	6.75	0.413	92.8															
4	09/06/05	10:47	Surface	0.1	25.7	74.4	6.14	6.64	0.545	80.6	2.8	3	4.1	0.1	0.59	0.56	0.03	0.04	0.029	< 0.005		6.8	5.11		
4	09/06/05	10:50	Middle	2.0	25.6	75.6	6.24	6.64	0.549	80.4															
4	09/06/05	10:53	Middle	5.0	25.6	74.4	6.14	6.63	0.552	80.1															
5	09/06/05	10:56	Bottom	8.0	25.6	73.1	6.04	6.64	0.554	80.3															
5	09/06/05	11:11	Surface	0.1	26.3	76.1	6.20	6.73	0.519	82.6	2.6	<1	4.7	0.1	0.46	0.46	<0.01	0.04	0.027	< 0.005		4.2	5.25		
5	09/06/05	11:14	Middle	1.0	26.3	76.0	6.19	6.74	0.522	82.6															
5	09/06/05	11:17	Middle	4.0	26.3	75.4	6.14	6.73	0.529	82.5															
5	09/06/05	11:20	Middle	7.0	26.3	75.2	6.13	6.72	0.534	82.6															
5	09/06/05	11:23	Middle	10.0	26.3	75.0	6.11	6.72	0.538	82.8					0.40	0.40	<0.01	0.04	0.028	< 0.005					
5	09/06/05	11:26	Middle	13.0	26.3	74.4	6.07	6.73	0.540	82.6					0.40	0.40	<0.01	0.04	0.028	< 0.005					
5	09/06/05	11:29	Bottom	16.0	26.3	69.4	5.66	6.69	0.527	83.0					0.40	0.40	<0.01	0.04	0.028	< 0.005					
6	09/06/05	11:40	Surface	0.1	26.2	74.7	6.10	6.72	0.548	83.2	2.5	2	4.8	0.1	0.34	0.34	<0.01	0.04	0.024	< 0.005		4.8	5.19		
6	09/06/05	11:43	Middle	3.0	26.2	75.7	6.18	6.75	0.548	83.0															
6	09/06/05	11:46	Middle	6.0	26.2	79.6	6.50	6.77	0.548	82.0															
6	09/06/05	11:49	Middle	9.0	26.2	77.7	6.35	6.73	0.551	82.8															
6	09/06/05	11:52	Bottom	12.0	26.1	73.3	5.99	6.71	0.554	83.2															
7	09/06/05	11:56	Surface	0.1	26.1	82.5	6.76	6.77	0.544	80.6	2.0	14	5.0	0.1	0.32	0.32	<0.01	0.03	0.034	< 0.005		8.8	7.89		
7	09/06/05	11:59	Middle	3.0	26.1	81.7	6.69	6.73	0.548	80.1															
7	09/06/05	12:02	Middle	6.0	26.1	80.6	6.60	6.75	0.550	80.1															
7	09/06/05	12:05	Bottom	9.0	26.1	79.5	6.51	6.76	0.539	80.1															
8	09/06/05	12:12	Surface	0.1	26.8	59.8	4.83	6.57	0.455	83.4	2.4	11	3.6	0.1	0.32	0.32	<0.01	0.04	0.028	< 0.005		4.8	4.86		
8	09/06/05	12:15	Middle	2.0	26.8	60.1	4.86	6.58	0.491	83.4															
8	09/06/05	12:18	Middle	5.0	26.8	60.7	4.91	6.57	0.506	83.5															
8	09/06/05	12:21	Middle	8.0	26.6	56.6	4.59	6.56	0.517	84.0															
8	09/06/05	12:24	Middle	11.0	26.5	57.8	4.70	6.58	0.522	83.9					0.56	0.56	<0.01	0.08	0.027	< 0.005					
8	09/06/05	12:27	Middle	14.0	26.1	23.5	1.92	6.50	0.526	92.6															
8	09/06/05	12:30	Middle																						

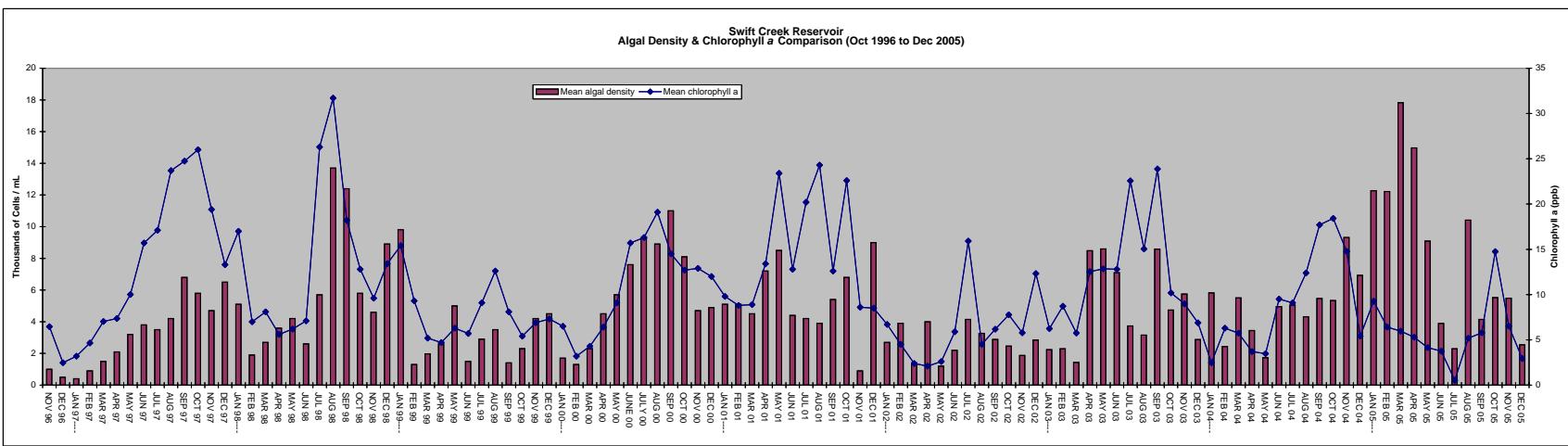
\* Total nitrogen is calculated as the sum of total kjeldahl nitrogen and total oxidized nitrogen.

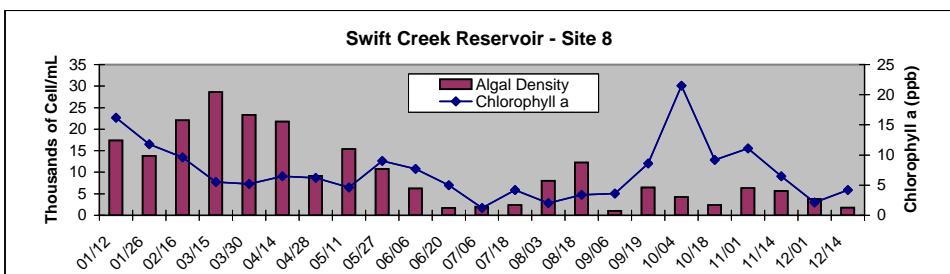
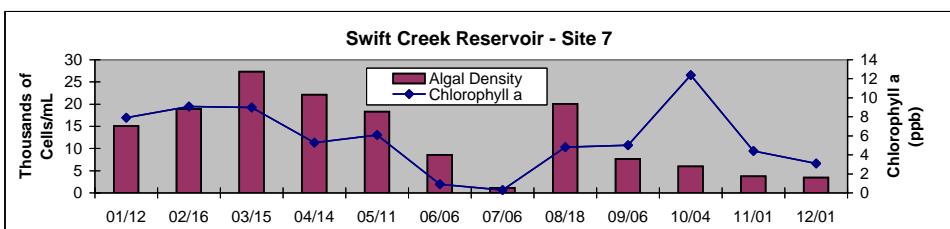
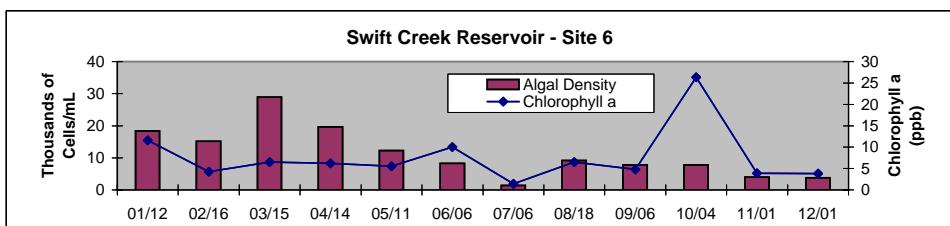
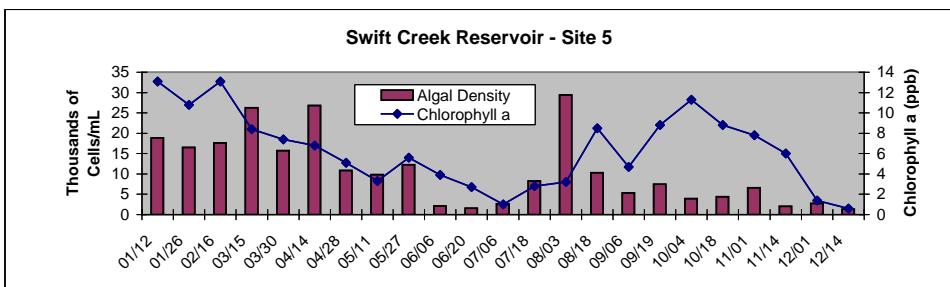
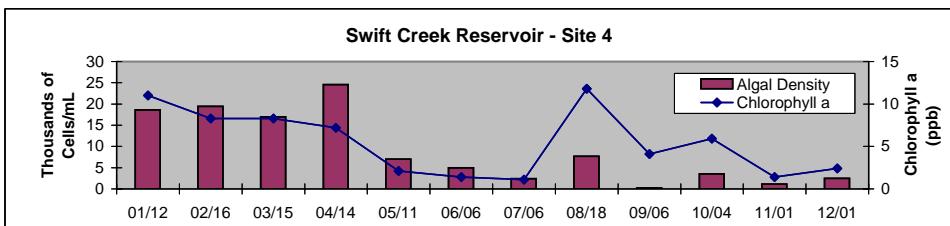
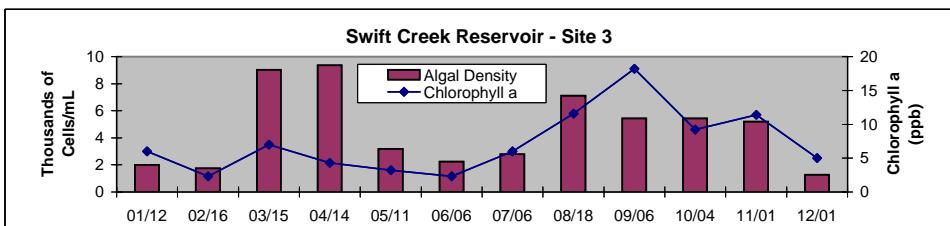
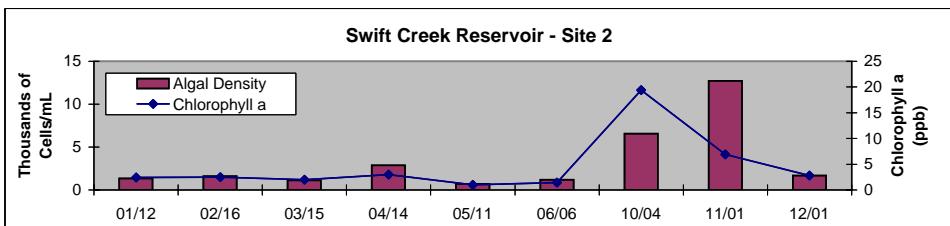
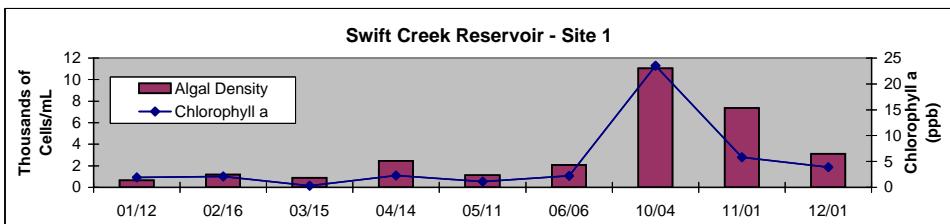
\*\* Data excluded due to analytical error.

\*\*\* Orthophosphate measured greater than total phosphorus, however within analytical methods error.

CHESTERFIELD COUNTY UTILITIES DEPARTMENT																									
ADDISON-EVANS WATER PRODUCTION FACILITY																									
RESULTS OF 2005 RESERVOIR SURVEY WATER QUALITY ANALYSES (JANUARY - DECEMBER)																									
STATION	DATE	TIME	DEPTH TXT	DEPTH (Feet)	TEMPERATURE (Degrees Celsius)	DISSOLVED OXYGEN (% Saturation)	DISSOLVED OXYGEN (mg/L)	pH	ORP (Volts)	CONDUCTIVITY (micro-mhos/cm)	SECCHI DISK (Feet)	FECAL COLIFORM (Colonies/100mL)	CHLOROPHYLL a (ppb)	PHEOPHYTIN a (ppb)	TOTAL NITROGEN* (mg/L)	TOTAL KJELDAHL NITROGEN (mg/L)	OXIDIZED NITROGEN (mg/L)	AMMONIA NITROGEN (mg/L)	TOTAL PHOSPHORUS (mg/L)	ORTHOPHOSPHATE PHOSPHORUS (mg/L)	ORGANIC CARBON (mg/L)	SUSPENDED SOLIDS (mg/L)	TOTAL TURBIDITY (ntu)	LEAD (mg/L)	ZINC (mg/L)
8	11/14/05	08:51	Middle	10.0	14.5	78.8	8.07	6.43	0.612	74.7					0.74	0.67	0.07	0.10	0.023	0.007					
8	11/14/05	08:53	Middle	13.0	14.4	74.3	7.63	6.35	0.616	74.5															
8	11/14/05	08:55	Middle	16.0	14.4	70.5	7.25	6.33	0.618	74.7															
8	11/14/05	08:57	Middle	19.0	14.3	69.1	7.11	6.29	0.622	75.0															
8	11/14/05	08:59	Bottom	22.0	14.3	61.3	6.31	6.85	0.544	75.8						0.77	0.70	0.07	0.10	0.023	0.007				
1	12/01/05	10:05	Surface	0.1	10.4	85.4	9.52	6.33	0.714	43.0	4.0	37	3.9	0.1	0.420	0.41	0.01	0.21	0.062	0.009		8.5	9.14		
1	12/01/05	10:07	Middle	2.0	9.71	81.0	9.18	6.39	0.710	42.0															
1	12/01/05	10:09	Bottom	5.0	9.28	78.4	8.98	6.40	0.709	41.0															
2	12/01/05	10:20	Surface	0.1	11.2	89.9	9.85	6.49	0.712	41.0	4.0	42	2.8	0.1	0.53	0.51	0.02	0.21	0.042	0.005		<2	11.05		
2	12/01/05	10:22	Middle	2.0	11.2	89.5	9.79	6.45	0.710	41.0															
2	12/01/05	10:24	Bottom	5.0	11.2	86.8	9.51	6.40	0.712	41.0															
3	12/01/05	10:48	Surface	0.1	11.0	97.9	10.8	6.44	0.659	36.0	2.5	291	5.0	0.2	0.57	0.50	0.07	0.28	0.044	0.007		4.0	39.35		
3	12/01/05	10:50	Middle	1.0	10.9	94.6	10.4	6.49	0.656	36.0															
3	12/01/05	10:52	Middle	4.0	10.8	93.9	10.4	6.57	0.656	36.0															
3	12/01/05	10:54	Bottom	7.0	10.8	90.7	10.0	6.56	0.655	36.0															
4	12/01/05	10:35	Surface	0.1	10.7	87.2	9.66	6.69	0.674	56.0	3.8	59	2.4	0.1	0.48	0.39	0.09	0.25	0.023	< 0.005		<2	7.59		
4	12/01/05	10:37	Middle	2.0	10.6	86.9	9.64	6.70	0.670	56.0															
4	12/01/05	10:39	Middle	5.0	10.6	86.6	9.62	6.74	0.667	56.0															
4	12/01/05	10:41	Bottom	8.0	10.5	86.5	9.63	6.74	0.663	56.0															
5	12/01/05	11:00	Surface	0.1	11.0	97.0	10.7	6.41	0.670	36.0	4.3	112	1.4	<0.1	0.52	0.42	0.10	0.25	0.025	< 0.005		<2	5.39		
5	12/01/05	11:02	Middle	3.0	11.0	97.0	10.7	6.61	0.667	35.0															
5	12/01/05	11:04	Middle	6.0	10.9	96.4	10.6	6.69	0.663	36.0															
5	12/01/05	11:06	Middle	9.0	10.8	94.7	10.5	6.63	0.662	36.0															
5	12/01/05	11:08	Middle	10.0	10.5	92.4	10.3	6.55	0.665	36.0															
5	12/01/05	11:10	Bottom	20.0	10.5	91.0	10.1	6.57	0.663	36.0															
6	12/01/05	11:18	Surface	0.1	10.8	96.5	10.7	6.63	0.664	36.0	4.5	93	3.8	<0.1	0.55	0.45	0.10	0.25	0.026	< 0.005		2.0	5.03		
6	12/01/05	11:20	Middle	1.0	10.9	96.5	10.6	6.67	0.661	36.0															
6	12/01/05	11:22	Middle	4.0	10.8	96.2	10.6	6.68	0.660	35.0															
6	12/01/05	11:24	Middle	7.0	10.8	95.6	10.6	6.63	0.660	36.0															
6	12/01/05	11:26	Middle	10.0	10.7	94.8	10.5	6.63	0.660	36.0															
6	12/01/05	11:28	Bottom	13.0	10.5	94.5	10.5	6.62	0.660	36.0															
7	12/01/05	11:35	Surface	0.1	10.4	94.9	10.6	6.68	0.602	36.0	4.5	37	3.1	0.1	0.43	0.33	0.10	0.25	0.028	< 0.005		<2	9.34		
7	12/01/05	11:37	Middle	2.0	10.4	94.4	10.5	6.67	0.602	36.0															
7	12/01/05	11:39	Middle	5.0	10.2	93.7	10.5	6.66	0.602	36.0															
7	12/01/05	11:41	Bottom	8.0	10.1	92.5	10.4	6.59	0.604	36.0															
8	12/01/05	11:50	Surface	0.1	10.4	93.0	10.4	6.56	0.613	35.0															

# **Appendix C: Reservoir Algae Data**





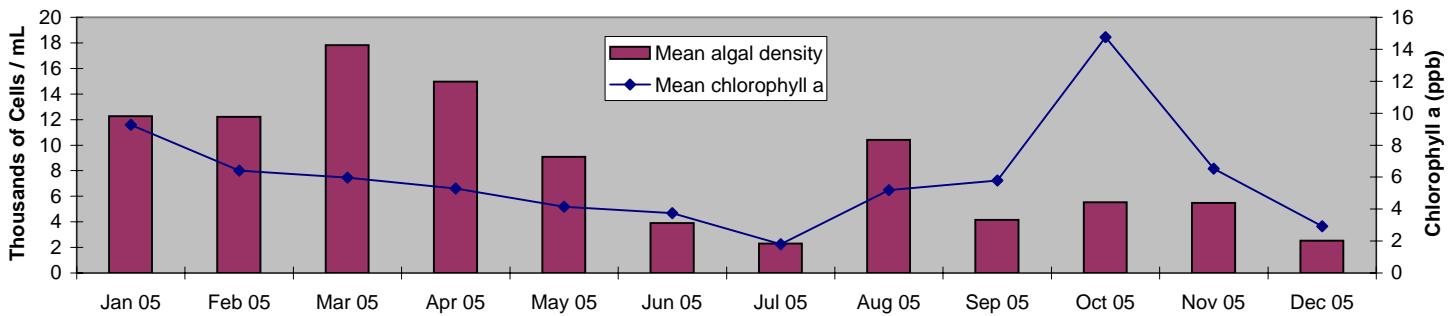
**Swift Creek Reservoir 2005 Summary:**

2005 Chlorophyll a	Jan 05	Feb 05	Mar 05	Apr 05	May 05	Jun 05	Jul 05	Aug 05	Sep 05	Oct 05	Nov 05	Dec 05
Site #1	1.9	2.1	0.3	2.3	1.1	2.2	0	0	0	23.5	5.8	3.9
Site #2	2.4	2.5	2	3	1	1.4	0	0	0	19.4	6.9	2.8
Site #3	6	2.3	7	4.3	3.2	2.3	6	11.6	18.2	9.2	11.4	5
Site #4	11	8.3	8.3	7.2	2.1	1.4	1.1	11.8	4.1	5.9	1.4	2.4
Site #5	13.1	13.1	8.4	6.8	3.3	3.9	1	8.5	4.7	11.3	7.8	1.4
Site #6	11.6	4.3	6.5	6.2	5.5	10	1.4	6.5	4.8	26.3	3.9	3.8
Site #7	7.9	9.1	9	5.3	6.1	0.9	0.3	4.8	5	12.4	4.4	3.1
Site #8	16.2	9.6	5.5	6.5	4.6	7.7	1.2	3.4	3.6	21.5	11.1	2.1
Supplemental Site #5	10.8	0	7.4	5.1	5.6	2.7	2.8	3.2	8.8	8.8	6	0.6
Supplemental Site #8	11.8	0	5.2	6.2	9	5	4.2	2	8.6	9.2	6.5	4.2
Mean Chlorophyll a ppb	9.27	6.4125	5.96	5.29	4.15	3.75	1.8	5.18	5.78	14.75	6.52	2.93

2005 Algal Density	Jan 05	Feb 05	Mar 05	Apr 05	May 05	Jun 05	Jul 05	Aug 05	Sep 05	Oct 05	Nov 05	Dec 05
Site #1	640	1200	880	2480	1120	2080	0	0	0	11040	7360	3120
Site #2	1360	1600	1120	2880	720	1200	0	0	0	6560	12720	1680
Site #3	2000	1760	9040	9360	3200	2240	2800	7120	5440	5440	5200	1280
Site #4	18640	19440	16960	24560	7040	4960	2400	7680	240	3520	1120	2480
Site #5	18880	17600	26240	26800	9840	2160	2640	10320	5360	3920	6640	2720
Site #6	18400	15200	28880	19680	12240	8240	1380	9200	7760	7760	4000	3760
Site #7	15040	18880	27360	22160	18320	8560	1120	20080	7680	6000	3760	3440
Site #8	17360	22080	28640	21760	15360	6240	2000	12240	1040	4240	6320	3760
Supplemental Site #5	16480	0	15760	10880	12240	1600	8240	29440	7440	4400	2080	1360
Supplemental Site #8	13840	0	23360	9120	10800	1680	2400	8000	6480	2400	5680	1760
Mean Cells/mL	12264	12220	17824	14968	9088	3896	2298	10408	4144	5528	5488	2536

	Jan 05	Feb 05	Mar 05	Apr 05	May 05	Jun 05	Jul 05	Aug 05	Sep 05	Oct 05	Nov 05	Dec 05
Mean algal density	12.264	12.22	17.824	14.968	9.088	3.896	2.298	10.408	4.144	5.528	5.488	2.536
Mean chlorophyll a	9.27	6.4125	5.96	5.29	4.15	3.75	1.8	5.18	5.78	14.75	6.52	2.93

**Swift Creek Reservoir - 2005**

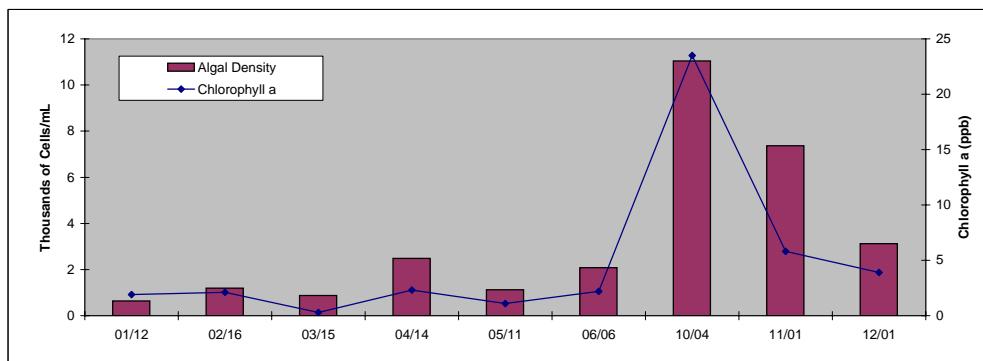


CHESTERFIELD COUNTY UTILITIES  
ADDISON-EVANS WATER PRODUCTION AND LABORATORY FACILITY

2005 PHYTOPLANKTON ASSESSMENT OF SWIFT CREEK RESERVOIR SITE 1

PHYTOPLANKTON CELL DENSITY COUNTS (Cells / mL)									
TAXON	01/12	02/16	03/15	04/14	05/11	06/06	10/04	11/01	12/01
<b>CHLOROPHYTA</b>									
<i>Ankistrodesmus</i>	0	80	0	0	320	400	1760	640	320
<i>Chlorella</i>	240	0	0	0	0	0	0	0	0
<i>Chotadella</i>	80	0	0	0	0	0	160	80	0
<i>Closteriopsis</i>	0	0	0	0	0	0	320	0	0
<i>Crucigenia</i>	0	0	0	0	320	640	960	2880	0
<i>Dictyosphaerium</i>	0	0	0	0	320	0	880	240	0
<i>Euastrum</i>	0	0	0	0	0	0	160	0	0
<i>Raciborskia*</i>	-	-	-	-	-	-	-	-	1280
<i>Scenedesmus</i>	0	0	0	0	0	0	800	320	0
<i>Tetraedron</i>	80	0	0	0	0	320	0	80	80
<b>CHRYOSOPHYTA</b>									
<i>Asterionella</i>	0	80	320	0	0	0	0	0	0
<i>Chrysochromulina</i>	0	80	0	560	80	0	0	0	400
<i>Chrysococcus</i>	0	880	480	0	0	0	480	1680	800
<i>Cyclotella</i>	0	0	0	0	0	0	160	240	0
<i>Dinobryon</i>	0	0	0	80	0	240	0	320	0
<i>Kephyrion</i>	80	0	0	240	0	0	0	0	0
<i>Nitzschia</i>	0	0	80	160	0	80	320	80	80
<i>Stipitococcus</i>	0	0	0	0	0	0	80	0	0
<i>Synedra</i>	80	0	0	80	0	0	0	0	0
<b>EUGLENOPHYTA</b>									
<i>Euglena</i>	80	0	0	0	0	0	80	80	0
<i>Trachelomonas</i>	0	0	0	0	0	0	400	0	0
<b>CRYPTOPHYTA</b>									
<i>Chroomonas</i>	0	80	0	960	80	320	0	0	0
<i>Cryptomonas</i>	0	0	0	320	0	80	240	640	160
<i>Rhodomonas</i>	0	0	0	80	0	0	160	0	0
<b>PYRRHOPHYTA</b>									
<i>Glenodinium</i>	0	0	0	0	0	0	240	80	0
<b>CYANOPROKARYOTA</b>									
<i>Merismopedia</i>	0	0	0	0	0	0	3840	0	0
<b>SUMMARY STATISTICS</b>									
<b>DENSITY (Cells / mL):</b>									
CHLOROPHYTA	400	80	0	0	960	1360	5040	4240	1680
CHRYSOPHYTA	160	1040	880	1120	80	320	1040	2320	1280
EUGLENOPHYTA	80	0	0	0	0	0	480	80	0
CRYPTOPHYTA	0	80	0	1360	80	400	400	640	160
PYRRHOPHYTA	0	0	0	0	0	0	240	80	0
CYANOPROKARYOTA	0	0	0	0	0	0	3840	0	0
UNKNOWN ALGAE	0	0	0	0	0	0	0	0	0
TOTAL	640	1200	880	2480	1120	2080	11040	7360	3120
<b>RELATIVE ABUNDANCE:</b>									
CHLOROPHYTA	62.5%	6.7%	0.0%	0.0%	85.7%	65.4%	45.7%	57.6%	53.8%
CHRYSOPHYTA	25.0%	86.7%	100.0%	45.2%	7.1%	15.4%	9.4%	31.5%	41.0%
EUGLENOPHYTA	12.5%	0.0%	0.0%	0.0%	0.0%	0.0%	4.3%	1.1%	0.0%
CRYPTOPHYTA	0.0%	6.7%	0.0%	54.8%	7.1%	19.2%	3.6%	8.7%	5.1%
PYRRHOPHYTA	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	2.2%	1.1%	0.0%
CYANOPROKARYOTA	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	34.8%	0.0%	0.0%
UNKNOWN ALGAE	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
TOTAL	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%
<b>TAXONOMIC RICHNESS:</b>									
CHLOROPHYTA	3	1	0	0	3	3	7	6	3
CHRYSOPHYTA	2	3	3	5	1	2	4	4	3
EUGLENOPHYTA	1	0	0	0	0	0	2	1	0
CRYPTOPHYTA	0	1	0	3	1	2	2	1	1
PYRRHOPHYTA	0	0	0	0	0	0	1	1	0
CYANOPROKARYOTA	0	0	0	0	0	0	1	0	0
UNKNOWN ALGAE	0	0	0	0	0	0	0	0	0
TOTAL	6	5	3	8	5	7	17	13	7
<b>CHLOROPHYLL a (ug / L):</b>									
TOTAL	1.9	2.1	0.3	2.3	1.1	2.2	23.5	5.8	3.9

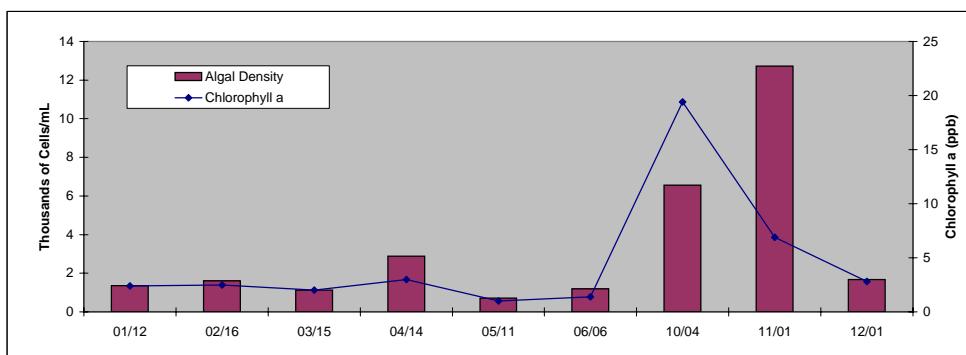
\* Identified on 12/01/05



CHESTERFIELD COUNTY UTILITIES  
ADDISON-EVANS WATER PRODUCTION AND LABORATORY FACILITY

2005 PHYTOPLANKTON ASSESSMENT OF SWIFT CREEK RESERVOIR SITE 2

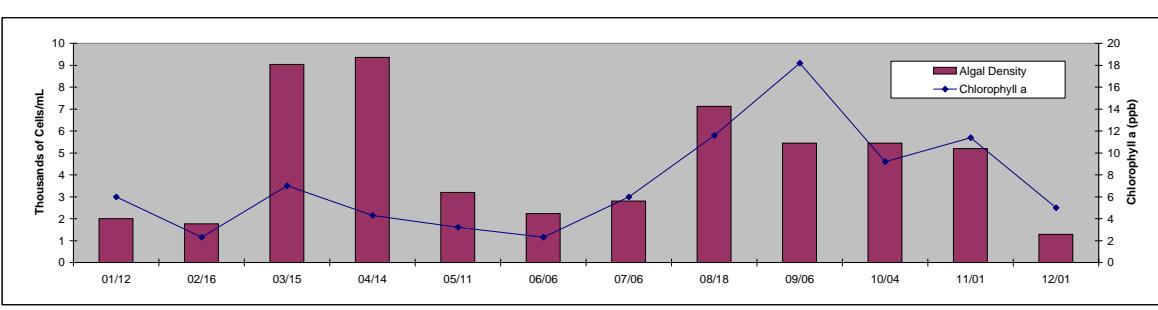
PHYTOPLANKTON CELL DENSITY COUNTS (Cells / mL)									
TAXON	01/12	02/16	03/15	04/14	05/11	06/06	10/04	11/01	12/01
<b>CHLOROPHYTA</b>									
<i>Ankistrodesmus</i>	80	0	240	80	240	320	960	1680	560
<i>Chotadella</i>	0	0	0	0	80	0	0	80	0
<i>Closteriopsis</i>	0	0	0	0	0	0	480	80	0
<i>Crucigenia</i>	640	0	0	0	0	0	640	2480	0
<i>Dictyosphaerium</i>	0	0	0	0	0	0	1840	1920	0
<i>Elakatothrix</i>	0	0	0	0	0	0	160	0	0
<i>Euastrum</i>	0	0	0	0	0	0	320	480	0
<i>Kirchneriella</i>	0	0	0	0	0	0	0	320	0
<i>Micrasterias</i>	0	0	0	0	0	0	320	0	0
<i>Scenedesmus</i>	0	0	0	0	0	0	480	0	0
<i>Tetraedron</i>	0	0	0	0	0	320	80	0	0
<i>Treubaria</i>	0	0	0	0	0	0	80	0	0
<b>CHRYPSOPHYTA</b>									
<i>Attheya</i>	0	0	0	0	0	0	80	0	0
<i>Chrysocromulina</i>	240	960	560	1840	0	0	0	0	400
<i>Chrysococcus</i>	80	80	0	0	0	0	320	640	0
<i>Cyclotella</i>	0	0	0	0	0	0	80	80	0
<i>Diceras</i>	0	0	0	0	0	0	0	80	0
<i>Dinobryon</i>	0	80	80	160	0	160	80	1840	0
<i>Kephyrion</i>	160	0	0	0	0	80	0	240	0
<i>Mallomonas</i>	0	0	0	80	80	0	0	0	0
<i>Nitzschia</i>	0	80	0	0	80	0	80	160	160
<i>Rhizosolenia</i>	0	160	160	80	0	0	0	0	0
<b>EUGLENOPHYTA</b>									
<i>Euglena</i>	0	0	0	0	0	0	80	0	0
<i>Phacus</i>	0	0	0	80	0	0	0	0	0
<i>Trachelomonas</i>	0	0	0	0	0	0	160	0	0
<b>CRYPTOPHYTA</b>									
<i>Chroomonas</i>	80	80	80	320	240	320	0	0	400
<i>Cryptomonas</i>	80	160	0	80	0	0	240	80	80
<i>Rhodomonas</i>	0	0	0	160	0	0	0	0	0
<b>PYRRHOPHYTA</b>									
<i>Glenodinium</i>	0	0	0	0	0	0	80	0	80
<b>CYANOPROKARYOTA</b>									
<i>Merismopedia</i>	0	0	0	0	0	0	0	2560	0
<b>SUMMARY STATISTICS</b>									
<b>DENSITY (Cells / ml):</b>									
CHLOROPHYTA	720	0	240	80	320	640	5360	7040	560
CHRYPSOPHYTA	480	1360	800	2160	160	240	640	3040	560
EUGLENOPHYTA	0	0	0	80	0	0	240	0	0
CRYPTOPHYTA	160	240	80	560	240	320	240	80	480
PYRRHOPHYTA	0	0	0	0	0	0	80	0	80
CYANOPROKARYOTA	0	0	0	0	0	0	0	2560	0
UNKNOWN ALGAE	0	0	0	0	0	0	0	0	0
TOTAL	1360	1600	1120	2880	720	1200	6560	12720	1680
<b>RELATIVE ABUNDANCE:</b>									
CHLOROPHYTA	52.9%	0.0%	21.4%	2.8%	44.4%	53.3%	81.7%	55.3%	33.3%
CHRYPSOPHYTA	35.3%	85.0%	71.4%	75.0%	22.2%	20.0%	9.8%	23.9%	33.3%
EUGLENOPHYTA	0.0%	0.0%	0.0%	2.8%	0.0%	0.0%	3.7%	0.0%	0.0%
CRYPTOPHYTA	11.8%	15.0%	7.1%	19.4%	33.3%	26.7%	3.7%	0.6%	28.6%
PYRRHOPHYTA	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	1.2%	0.0%	4.8%
CYANOPROKARYOTA	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	20.1%	0.0%
UNKNOWN ALGAE	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
TOTAL	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%
<b>TAXONOMIC RICHNESS:</b>									
CHLOROPHYTA	3	0	1	1	2	2	10	7	1
CHRYPSOPHYTA	2	5	3	4	2	2	5	6	2
EUGLENOPHYTA	1	0	0	0	0	0	2	0	0
CRYPTOPHYTA	0	2	1	0	1	1	1	1	2
PYRRHOPHYTA	0	0	0	0	0	0	1	0	1
CYANOPROKARYOTA	0	0	0	0	0	0	0	1	0
UNKNOWN ALGAE	0	0	0	0	0	0	0	0	0
TOTAL	6	7	5	5	5	5	19	15	6
<b>CHLOROPHYLL a (ug / L):</b>									
TOTAL	2.4	2.5	2	3	1	1.4	19.4	6.9	2.8



CHESTERFIELD COUNTY UTILITIES  
ADDISON-EVANS WATER PRODUCTION AND LABORATORY FACILITY

2005 PHYTOPLANKTON ASSESSMENT OF SWIFT CREEK RESERVOIR SITE 3

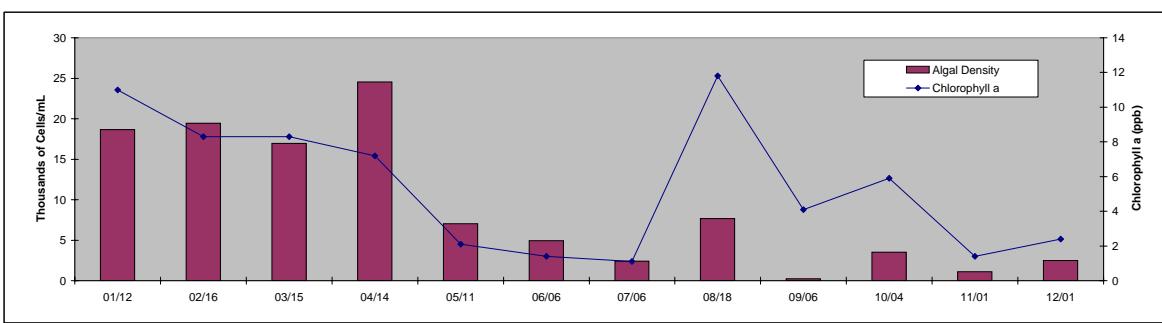
PHYTOPLANKTON CELL DENSITY COUNTS (Cells / mL)												
TAXON	01/12	02/16	03/15	04/14	05/11	06/06	07/06	08/18	09/06	10/04	11/01	12/01
<b>CHLOROPHYTA</b>												
<i>Ankistrodesmus</i>	160	80	880	160	480	640	0	80	320	320	320	160
<i>Chotadella</i>	0	0	80	160	80	0	0	0	0	0	0	0
<i>Closteriopsis</i>	0	0	0	0	0	0	0	80	400	160	0	0
<i>Crucigenia</i>	0	0	0	0	0	0	480	0	640	0	960	0
<i>Dictyosphaerium</i>	0	0	480	880	0	160	640	640	1520	1520	0	320
<i>Euastrum</i>	0	0	0	0	0	0	0	0	160	160	320	0
<i>Golenkinia</i>	0	0	0	0	0	0	160	80	0	0	0	0
<i>Micractinium</i>	0	0	0	0	0	0	0	0	0	0	400	0
<i>Micrasterias</i>	0	0	0	0	0	0	0	0	0	560	0	0
<i>Oocysts</i>	0	0	0	0	0	0	0	320	0	0	0	0
<i>Scenedesmus</i>	0	0	0	0	160	0	0	800	800	640	320	240
<i>Tetraedron</i>	160	80	240	0	480	240	0	0	0	0	80	0
<i>Ulothrix</i>	0	0	0	0	0	0	0	0	80	0	0	0
<b>CHRYPSOPHYTA</b>												
<i>Asterionella</i>	0	0	0	480	0	0	0	0	0	0	0	0
<i>Chryschromulina</i>	320	1040	5040	5600	160	240	0	0	80	0	1200	0
<i>Chrysococcus</i>	0	0	80	0	0	0	400	0	240	0	240	0
<i>Cyclotella</i>	0	0	0	0	80	0	0	80	80	80	480	0
<i>Diceras</i>	0	0	0	0	0	0	0	80	0	0	80	0
<i>Dinobryon</i>	640	80	0	0	0	640	80	0	0	80	0	0
<i>Kephryion</i>	0	0	80	80	0	240	0	0	0	0	480	320
<i>Mallomonas</i>	80	0	0	0	0	0	0	0	0	80	0	0
<i>Melosira</i>	0	160	0	1600	0	0	0	0	0	0	0	0
<i>Navicula</i>	0	0	0	0	0	0	0	0	0	80	160	80
<i>Nitzschia</i>	160	80	640	0	1600	0	0	240	320	240	160	0
<i>Rhizosolenia</i>	400	160	1120	160	0	0	0	80	0	0	0	0
<b>EUGLENOPHYTA</b>												
<i>Euglena</i>	0	0	0	0	0	0	160	160	80	0	0	80
<i>Trachelomonas</i>	0	0	0	0	0	0	480	240	240	160	0	0
<b>CRYPTOPHYTA</b>												
<i>Chroomonas</i>	0	0	80	0	0	0	0	320	80	0	0	0
<i>Cryptomonas</i>	80	80	320	160	160	0	240	320	320	160	0	0
<i>Rhodomonas</i>	0	0	0	80	0	0	0	0	0	0	0	0
<b>PYRRHOPHYTA</b>												
<i>Glenodinium</i>	0	0	0	0	0	80	80	0	80	0	0	80
<i>Peridinium</i>	0	0	0	0	0	0	80	0	0	0	0	0
<b>CYANOPROKARYOTA</b>												
<i>Anabaena</i>	0	0	0	0	0	0	0	3600	0	0	0	0
<i>Microcystis</i>	0	0	0	0	0	0	0	0	0	1200	0	0
SUMMARY STATISTICS												
<b>DENSITY (Cells / ml):</b>												
CHLOROPHYTA	320	160	1680	1200	1200	1040	1280	2000	3920	3360	2400	720
CHRYPSOPHYTA	1600	1520	6960	7920	1840	1120	480	720	560	2800	400	
EUGLENOPHYTA	0	0	0	0	0	640	400	320	160	0	80	
CRYPTOPHYTA	80	80	400	240	160	0	240	640	400	160	0	0
PYRRHOPHYTA	0	0	0	0	0	80	160	0	80	0	0	80
CYANOPROKARYOTA	0	0	0	0	0	0	0	3600	0	1200	0	0
UNKNOWN ALGAE	0	0	0	0	0	0	0	0	0	0	0	0
TOTAL	2000	1760	9040	9360	3200	2240	2800	7120	5440	5440	5200	1280
<b>RELATIVE ABUNDANCE:</b>												
CHLOROPHYTA	16.0%	9.1%	18.6%	12.8%	37.5%	46.4%	45.7%	28.1%	72.1%	61.8%	46.2%	56.3%
CHRYPSOPHYTA	80.0%	86.4%	77.0%	84.6%	57.5%	50.0%	17.1%	6.7%	13.2%	10.3%	53.8%	31.3%
EUGLENOPHYTA	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	22.9%	5.6%	5.9%	2.9%	0.0%	6.3%
CRYPTOPHYTA	4.0%	4.5%	4.4%	2.6%	5.0%	0.0%	8.6%	9.0%	7.4%	2.9%	0.0%	0.0%
PYRRHOPHYTA	0.0%	0.0%	0.0%	0.0%	0.0%	3.6%	5.7%	0.0%	1.5%	0.0%	0.0%	6.3%
CYANOPROKARYOTA	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	50.6%	0.0%	22.1%	0.0%	0.0%
UNKNOWN ALGAE	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
TOTAL	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%
<b>TAXONOMIC RICHNESS:</b>												
CHLOROPHYTA	3	2	4	3	4	3	3	6	7	6	6	3
CHRYPSOPHYTA	2	5	5	5	3	3	2	4	4	5	7	2
EUGLENOPHYTA	1	0	0	0	0	0	2	2	2	1	2	1
CRYPTOPHYTA	0	1	2	2	1	0	1	2	2	1	2	0
PYRRHOPHYTA	0	0	0	0	0	1	2	0	1	0	0	1
CYANOPROKARYOTA	0	0	0	0	0	0	0	1	0	1	1	0
UNKNOWN ALGAE	0	0	0	0	0	0	0	0	0	0	0	0
TOTAL	6	8	11	10	8	7	10	15	16	14	18	7
<b>CHLOROPHYLL a (ug / L):</b>												
TOTAL	6	2.3	7	4.3	3.2	2.3	6	11.6	18.2	9.2	11.4	5



CHESTERFIELD COUNTY UTILITIES  
ADDISON-EVANS WATER PRODUCTION AND LABORATORY FACILITY

2005 PHYTOPLANKTON ASSESSMENT OF SWIFT CREEK RESERVOIR SITE 4

PHYTOPLANKTON CELL DENSITY COUNTS (Cells / mL)												
TAXON	01/12	02/16	03/15	04/14	05/11	06/06	07/06	08/18	09/06	10/04	11/01	12/01
<b>CHLOROPHYTA</b>												
<i>Ankistrodesmus</i>	1040	960	1040	640	2960	1680	1120	80	0	800	160	240
<i>Chotadella</i>	160	240	320	320	160	0	0	0	0	0	0	0
<i>Closteriopsis</i>	0	0	0	240	80	0	0	160	80	80	0	0
<i>Crucigenia</i>	0	0	0	0	320	0	0	0	0	800	0	0
<i>Dictyosphaerium</i>	0	320	320	0	800	0	640	1600	0	1040	0	0
<i>Euastrum</i>	0	0	0	0	0	0	0	0	0	160	0	0
<i>Micractinium</i>	0	0	0	0	0	160	0	320	0	0	0	0
<i>Scenedesmus</i>	0	0	0	0	640	0	0	320	0	0	320	320
<i>Selenastrum</i>	0	0	0	0	0	0	0	0	80	0	0	0
<i>Staurastrum</i>	0	0	0	0	0	0	0	0	160	0	0	0
<i>Tetraedron</i>	880	480	240	560	800	1040	0	0	0	0	160	0
<i>Treubaria</i>	0	0	0	80	0	0	0	0	0	0	0	0
<i>Ulothrix</i>	0	0	0	0	0	0	0	0	160	0	0	0
<b>CHRYOSOPHYTA</b>												
<i>Asterionella</i>	0	0	0	560	0	160	0	0	0	0	0	0
<i>Chrysocromulina</i>	13280	14880	10480	19600	80	160	0	0	0	0	0	160
<i>Chrysococcus</i>	0	0	0	80	0	0	80	0	0	0	0	0
<i>Cyclotella</i>	0	0	0	160	80	0	320	240	0	480	80	0
<i>Diceras</i>	0	80	0	0	0	0	0	0	0	0	0	0
<i>Dinobryon</i>	80	80	960	0	0	560	0	0	0	0	0	0
<i>Kephryion</i>	0	0	0	160	0	160	0	0	0	80	0	0
<i>Mallomonas</i>	0	0	0	0	960	0	0	0	80	0	80	0
<i>Melosira</i>	1200	480	480	800	80	0	0	0	0	160	0	0
<i>Nitzschia</i>	240	560	720	160	80	160	0	160	0	0	0	0
<i>Rhizosolenia</i>	240	720	1920	480	0	0	0	0	0	0	0	0
<b>EUGLENOPHYTA</b>												
<i>Euglena</i>	0	0	0	80	0	0	0	0	0	0	0	0
<i>Trachelomonas</i>	0	0	0	0	0	0	240	480	0	0	0	0
<b>CRYPTOPHYTA</b>												
<i>Chroomonas</i>	160	80	160	0	0	640	0	160	0	0	160	1760
<i>Cryptomonas</i>	80	160	320	560	0	0	0	80	0	0	80	0
<i>Rhodomonas</i>	160	400	0	80	0	0	0	0	0	0	0	0
<b>PYRRHOPHYTA</b>												
<i>Glenodinium</i>	0	0	0	0	0	240	0	0	0	0	0	0
<b>CYANOPROKARYOTA</b>												
<i>Anabaena</i>	1120	0	0	0	0	0	0	3760	0	0	0	0
<b>SUMMARY STATISTICS</b>												
<b>DENSITY (Cells / ml):</b>												
CHLOROPHYTA	2080	2000	1920	1840	5760	2880	1760	2800	160	2880	640	560
CHRYOSOPHYTA	15040	16800	14560	22000	1280	1200	400	400	80	640	240	160
EUGLENOPHYTA	0	0	0	80	0	0	240	480	0	0	0	0
CRYPTOPHYTA	400	640	480	640	0	640	0	240	0	0	240	1760
PYRRHOPHYTA	0	0	0	0	0	240	0	0	0	0	0	0
CYANOPROKARYOTA	1120	0	0	0	0	0	0	3760	0	0	0	0
UNKNOWN ALGAE	0	0	0	0	0	0	0	0	0	0	0	0
<b>TOTAL</b>	18640	19440	16960	24560	7040	4960	2400	7680	240	3520	1120	2480
<b>RELATIVE ABUNDANCE:</b>												
CHLOROPHYTA	11.2%	10.3%	11.3%	7.5%	81.8%	58.1%	73.3%	36.5%	66.7%	81.8%	57.1%	22.6%
CHRYOSOPHYTA	80.7%	86.4%	85.8%	89.6%	18.2%	24.2%	16.7%	5.2%	33.3%	18.2%	21.4%	6.5%
EUGLENOPHYTA	0.0%	0.0%	0.0%	0.3%	0.0%	0.0%	10.0%	6.3%	0.0%	0.0%	0.0%	0.0%
CRYPTOPHYTA	2.1%	3.3%	2.8%	2.6%	0.0%	12.9%	0.0%	3.1%	0.0%	0.0%	21.4%	71.0%
PYRRHOPHYTA	0.0%	0.0%	0.0%	0.0%	0.0%	4.8%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
CYANOPROKARYOTA	6.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	49.0%	0.0%	0.0%	0.0%	0.0%
UNKNOWN ALGAE	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
<b>TOTAL</b>	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%
<b>TAXONOMIC RICHNESS:</b>												
CHLOROPHYTA	3	4	4	5	7	3	2	8	2	5	3	2
CHRYOSOPHYTA	5	6	5	8	5	5	2	2	1	2	3	1
EUGLENOPHYTA	0	0	0	1	0	0	1	1	0	0	0	0
CRYPTOPHYTA	3	3	2	2	0	1	0	2	0	0	2	1
PYRRHOPHYTA	0	0	0	0	0	1	0	0	0	0	0	0
CYANOPROKARYOTA	1	1	0	0	0	0	0	1	0	0	0	0
UNKNOWN ALGAE	0	0	0	0	0	0	0	0	0	0	0	0
<b>TOTAL</b>	12	13	11	16	12	10	5	14	3	7	8	4
<b>CHLOROPHYLL a (ug / L):</b>												
TOTAL	11	8.3	8.3	7.2	2.1	1.4	1.1	11.8	4.1	5.9	1.4	2.4



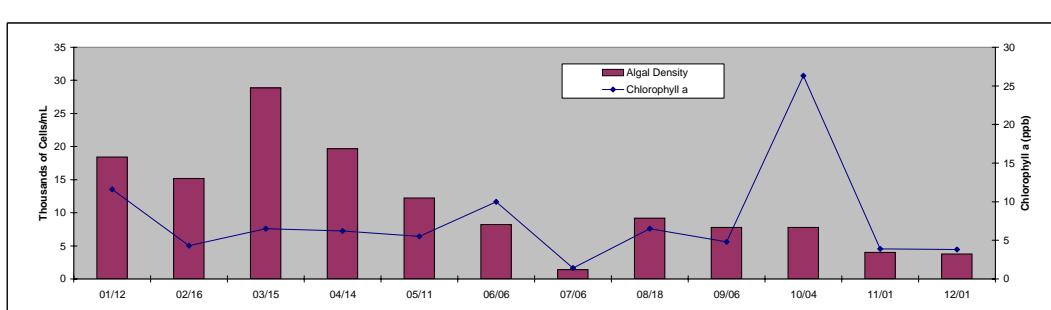
CHESTERFIELD COUNTY UTILITIES  
ADDISON-EVANS WATER PRODUCTION AND LABORATORY FACILITY  
2005 PHYTOPLANKTON ASSESSMENT OF SWIFT CREEK RESERVOIR SITE 5

PHYTOPLANKTON CELL DENSITY COUNTS (Cells / mL)																									
TAXON	01/12	01/26	02/16	03/15	03/30	04/14	04/28	05/11	05/27	06/06	06/20	07/06	07/18	08/03	08/18	09/06	09/19	10/04	10/18	11/01	11/14	12/01	12/14		
	Supplemental																								
<b>CHLOROPHYTA</b>																									
Ankistrodesmus	1040	720	880	1280	1200	720	2880	3200	0	560	1040	1920	480	80	240	80	160	720	480	480	160	560	240	0	
Chlamydomonas	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	320	
Chodatella	240	400	0	400	80	80	160	80	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
Closteropsis	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
Cyclotella	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
Crucerula	640	0	0	0	0	0	0	0	1120	640	0	0	0	240	960	0	0	2560	320	640	1120	320	0	0	
Dictyosphaerium	480	0	0	0	240	160	160	320	0	2160	0	0	0	240	1760	1280	0	1280	640	0	400	0	0	0	
Elatatrichia	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	160	80	0	0	0	160	
Eustromum	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	480	160	0	0	0	0	
Eufragaria	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
Kirchneriella	0	0	0	0	0	0	0	0	160	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
Micracanthium	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
Oocysts	0	0	0	0	400	160	0	0	0	0	0	240	0	0	240	0	0	0	480	0	0	0	0	0	
Pachycladon	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
Scenedesmus	0	160	0	0	0	320	320	160	880	0	0	0	0	0	0	0	0	640	320	560	0	0	0	0	
Sphaerotilus	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
Staurastrum	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	160	0	0	0	0	0	
Tetraedron	480	240	240	480	320	400	960	1360	640	400	80	0	0	0	0	0	0	80	80	0	0	0	80		
Treubaria	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
<b>CHRYSOphyta</b>																									
Astrocystis	0	0	0	0	0	0	480	2000	0	480	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
Chlorochromina	12400	12560	14000	18320	9120	20560	1360	320	1680	160	0	80	0	0	0	0	0	0	0	0	0	160	0	0	
Chlorococcus	80	80	0	160	0	160	0	0	80	0	0	0	0	0	0	0	0	80	0	0	0	80	0	0	
Cyclocteifa	80	0	80	160	0	80	0	80	0	0	0	160	0	0	0	0	0	320	80	720	240	400	160	0	
Dinobryon	0	0	0	0	0	80	0	0	0	480	0	0	0	0	160	0	0	0	0	0	0	0	0	0	
Kephryton	80	80	0	0	0	0	0	320	0	0	0	80	0	0	0	0	0	0	0	0	0	0	80	0	
Microcoleus	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
Mesocylia	2240	640	960	400	160	2400	2080	2320	400	160	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
Navicula	0	0	0	0	80	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
Nitzschia	160	160	320	1200	160	480	160	80	80	0	0	0	0	0	0	0	0	240	160	0	0	0	0	0	
Rhizosolenia	480	720	560	2480	2800	640	240	80	80	0	0	0	0	0	0	0	0	0	0	0	0	0	0	80	
<b>EUGLENOPHYTA</b>																									
Euglena	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	80	0	0	0	0	0	
Trachelomonas	0	0	0	0	0	0	80	0	0	0	80	0	0	0	0	0	0	160	0	80	0	0	0	0	
<b>CRYPTOPHYTA</b>																									
Chroomonas	240	560	160	400	160	0	0	0	0	80	0	0	0	0	0	0	0	0	80	0	0	0	0	0	
Cryptomonas	240	0	320	160	880	160	0	240	240	80	80	0	240	80	160	0	0	0	0	0	0	80	0	0	
Rhizomonas	0	160	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
<b>CYANOPROKARYOTA</b>																									
Anabaena	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	6480	22480	7520	4080	800	0	0	
Merismopedia	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
<b>SUMMARY STATISTICS:</b>																									
DENSITY (Cells / mL):	2880	1520	1120	2880	2400	1840	4560	6640	9280	960	1360	1920	1040	4480	1840	800	5840	3040	3040	1280	4080	560	640	800	
CHLOROPHYTA	15520	14240	16000	22800	12320	24800	6240	2960	2720	960	160	320	400	240	320	480	160	1520	320	800	160	240	0	0	
EUGLENOPHYTA	0	0	0	0	0	0	0	80	0	0	80	0	0	0	0	0	0	0	0	0	0	0	0	0	
CRYPTOPHYTA	480	720	480	560	1040	160	0	240	240	160	80	320	320	2240	480	80	240	80	320	2240	720	1920	0	320	
CYANOPROKARYOTA	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
UNKNOWN ALGAE	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
TOTAL	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%		
<b>RELATIVE ABUNDANCE:</b>																									
CHLOROPHYTA	15.3%	9.4%	6.4%	11.0%	15.2%	6.9%	41.9%	67.5%	75.8%	44.4%	85.0%	72.7%	12.6%	15.2%	17.8%	14.9%	78.5%	77.6%	29.1%	61.4%	26.9%	23.5%	58.8%		
CHRYSOphyta	82.2%	96.4%	90.9%	86.9%	78.2%	92.5%	57.4%	30.1%	22.2%	44.4%	10.0%	4.3%	3.1%	6.0%	6.5%	4.1%	34.5%	48.8%	38.5%	5.9%	17.6%	0.0%	0.0%		
EUGLENOPHYTA	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	
CRYPTOPHYTA	2.8%	4.5%	2.7%	2.1%	6.8%	7.3%	0.0%	0.0%	2.4%	2.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	12.1%	3.6%	2.3%	2.3%	2.3%	24.6%	70.6%	20.9%	
CYANOPROKARYOTA	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	78.6%	76.4%	72.9%	76.1%	10.8%	16.3%	29.1%	0.0%
UNKNOWN ALGAE	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	
TOTAL	14	12	10	15	14	14	13	11	10	5	6	10	12	9	8	13	12	8	9	8	4	9	8	6	
<b>CHLOROPHYLL a (ug / L):</b>	TOTAL	13.1	10.8	13.1	8.4	7.4	6.8	5.1	3.3	5.6	3.9	2.7	1	1	2.8	3.2	8.5	4.7							

CHESTERFIELD COUNTY UTILITIES  
ADDISON-EVANS WATER PRODUCTION AND LABORATORY FACILITY

2005 PHYTOPLANKTON ASSESSMENT OF SWIFT CREEK RESERVOIR SITE 6

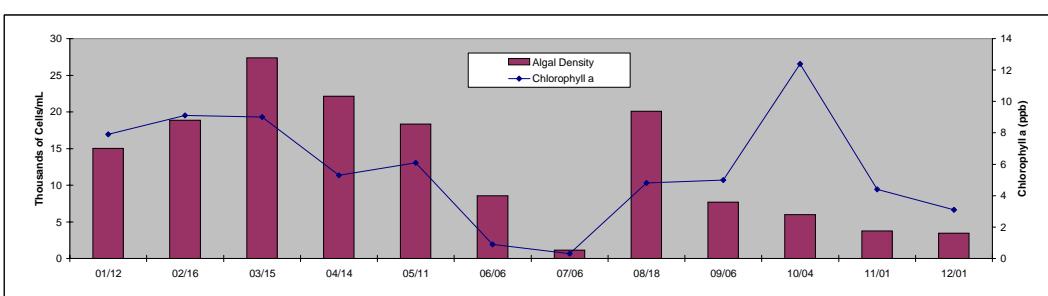
PHYTOPLANKTON CELL DENSITY COUNTS (Cells / mL)												
TAXON	01/12	02/16	03/15	04/14	05/11	06/06	07/06	08/18	09/06	10/04	11/01	12/01
<b>CHLOROPHYTA</b>												
<i>Ankistrodesmus</i>	800	1040	1840	0	2880	1120	420	80	160	1840	960	160
<i>Chotadella</i>	240	0	320	0	160	80	0	80	0	0	0	0
<i>Closteriopsis</i>	0	0	0	80	80	0	0	0	0	0	0	0
<i>Crucigenia</i>	320	320	320	320	1280	0	0	0	320	0	320	0
<i>Dictyosphaerium</i>	0	0	1360	0	160	0	0	0	480	3040	0	0
<i>Elakothrix</i>	0	0	0	0	0	0	0	0	80	0	0	160
<i>Euastrum</i>	0	160	0	0	0	0	0	0	0	160	0	0
<i>Golenkinia</i>	0	0	80	0	0	0	0	0	80	0	80	0
<i>Kirchneriella</i>	0	0	0	0	240	0	0	0	0	240	0	0
<i>Micractinium</i>	0	0	160	0	0	240	0	0	0	0	0	0
<i>Oocystis</i>	0	320	160	0	0	0	0	0	0	0	0	240
<i>Scenedesmus</i>	0	0	0	0	800	0	0	0	320	480	0	0
<i>Staurastrum</i>	0	0	0	0	0	0	0	160	80	0	0	0
<i>Tetraedron</i>	400	880	560	400	720	400	320	0	160	0	0	160
<i>Trebularia</i>	0	0	0	0	0	0	80	0	0	0	0	0
<b>CHRYPSOPHYTA</b>												
<i>Asterionella</i>	0	0	0	320	0	0	0	0	0	0	0	0
<i>Chryschromulina</i>	14800	10320	18000	15120	1600	1360	160	0	0	0	0	320
<i>Chrysococcus</i>	0	160	0	0	0	0	0	0	0	0	0	160
<i>Cyclotella</i>	80	0	0	0	240	80	0	240	160	160	480	0
<i>Diceras</i>	0	80	0	80	0	0	0	0	0	0	0	0
<i>Dinobryon</i>	0	0	240	320	0	3520	0	0	0	0	0	0
<i>Kephnyton</i>	0	0	0	0	80	80	0	0	0	0	0	80
<i>Mallomonas</i>	0	0	0	0	0	80	0	0	0	0	0	160
<i>Melosira</i>	960	320	480	1760	2480	320	0	0	320	320	800	0
<i>Nitzschia</i>	0	160	720	0	80	0	80	80	240	160	0	0
<i>Rhizosolenia</i>	240	960	3920	960	0	0	160	0	0	0	0	0
<i>Synedra</i>	0	0	0	80	0	0	0	0	0	0	0	0
<b>EUGLENOPHYTA</b>												
<i>Trachelomonas</i>	0	0	0	0	0	0	0	0	160	240	0	0
<b>CRYPTOPHYTA</b>												
<i>Chroomonas</i>	320	80	80	80	0	240	0	0	160	480	80	2240
<i>Cryptomonas</i>	160	320	560	160	160	480	0	80	160	640	0	80
<i>Rhodomonas</i>	80	80	80	0	0	0	0	0	0	0	0	0
<b>PYRRHOPHYTA</b>												
<i>Glenodinium</i>	0	0	0	0	0	320	80	0	0	0	0	0
<b>CYANOPROKARYOTA</b>												
<i>Anabaena</i>	0	0	0	0	0	0	0	8480	4880	0	0	0
<i>Merismopedia</i>	0	0	0	0	1280	0	0	0	0	0	0	0
<i>Microcystis</i>	0	0	0	0	0	0	0	0	0	0	1280	0
<b>SUMMARY STATISTICS</b>												
<b>DENSITY (Cells / ml):</b>												
CHLOROPHYTA	1760	2720	4800	800	6320	1840	820	320	1680	5760	1360	720
CHRYSOPHYTA	16080	12000	23360	18640	4480	5360	480	320	720	640	1280	720
EUGLENOPHYTA	0	0	0	0	0	0	0	0	160	240	0	0
CRYPTOPHYTA	560	480	720	240	160	720	0	80	320	1120	80	2320
PYRRHOPHYTA	0	0	0	0	0	320	80	0	0	0	0	0
CYANOPROKARYOTA	0	0	0	0	1280	0	0	8480	4880	0	1280	0
UNKNOWN ALGAE	0	0	0	0	0	0	0	0	0	0	0	0
TOTAL	18400	15200	28880	19680	12240	8240	1380	9200	7760	4000	3760	
<b>RELATIVE ABUNDANCE:</b>												
CHLOROPHYTA	9.6%	17.9%	16.6%	4.1%	51.6%	22.3%	59.4%	3.5%	21.6%	74.2%	34.0%	19.1%
CHRYSOPHYTA	87.4%	78.9%	80.9%	94.7%	36.6%	65.0%	34.8%	3.5%	9.3%	8.2%	32.0%	19.1%
EUGLENOPHYTA	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	2.1%	3.1%	0.0%	0.0%
CRYPTOPHYTA	3.0%	3.2%	2.5%	1.2%	1.3%	8.7%	0.0%	0.9%	4.1%	14.4%	2.0%	61.7%
PYRRHOPHYTA	0.0%	0.0%	0.0%	0.0%	0.0%	3.9%	5.8%	0.0%	0.0%	0.0%	0.0%	0.0%
CYANOPROKARYOTA	0.0%	0.0%	0.0%	0.0%	10.5%	0.0%	0.0%	92.2%	62.9%	0.0%	32.0%	0.0%
UNKNOWN ALGAE	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
TOTAL	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%
<b>TAXONOMIC RICHNESS:</b>												
CHLOROPHYTA	4	5	8	5	8	4	3	3	8	5	3	4
CHRYSOPHYTA	4	6	5	8	5	5	5	2	3	3	2	5
EUGLENOPHYTA	0	0	0	0	0	0	0	0	1	0	0	0
CRYPTOPHYTA	3	3	3	2	1	2	0	1	2	1	1	2
PYRRHOPHYTA	0	0	0	0	0	1	1	0	0	2	0	0
CYANOPROKARYOTA	0	0	0	0	1	0	0	1	1	0	1	0
UNKNOWN ALGAE	0	0	0	0	0	0	0	0	0	0	0	0
TOTAL	11	14	16	15	15	12	9	7	15	11	7	11
<b>CHLOROPHYLL a (ug / L):</b>												
TOTAL	11.6	4.3	6.5	6.2	5.5	10	1.4	6.5	4.8	26.3	3.9	3.8



CHESTERFIELD COUNTY UTILITIES  
ADDISON-EVANS WATER PRODUCTION AND LABORATORY FACILITY

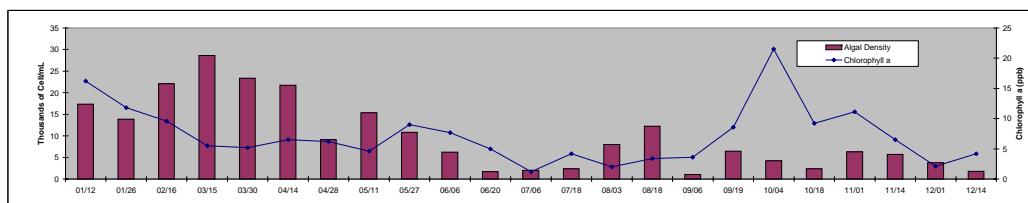
2005 PHYTOPLANKTON ASSESSMENT OF SWIFT CREEK RESERVOIR SITE 7

PHYTOPLANKTON CELL DENSITY COUNTS (Cells / mL)													
TAXON	01/12	02/16	03/15	04/14	05/11	06/06	07/06	08/18	09/06	10/04	11/01	12/01	
<b>CHLOROPHYTA</b>													
<i>Ankistrodesmus</i>	1040	640	2080	2480	2960	2160	800	240	400	3440	720	320	
<i>Chotadella</i>	160	320	720	400	80	0	0	80	0	0	0	0	
<i>Closteriopsis</i>	80	0	80	0	0	0	0	80	80	0	0	0	
<i>Crucigenia</i>	0	0	0	2560	1920	0	0	1200	0	320	1280	0	
<i>Dictyosphaerium</i>	0	320	640	320	0	0	0	1120	2480	720	0	0	
<i>Elakothrix</i>	0	0	0	0	0	0	0	0	80	80	0	0	
<i>Euastrum</i>	0	160	0	0	0	0	0	0	320	0	0	0	
<i>Kirchneriella</i>	0	0	0	0	320	0	0	0	0	0	0	0	
<i>Micracanthium</i>	0	0	0	0	0	80	0	240	0	0	0	0	
<i>Oocysts</i>	0	0	160	240	0	0	0	0	0	0	0	0	
<i>Pediastrum</i>	0	0	0	0	0	80	0	0	0	0	0	0	
<i>Scenedesmus</i>	0	0	0	0	640	0	0	320	320	0	0	320	
<i>Selenastrum</i>	0	0	0	0	0	0	0	80	0	0	0	0	
<i>Tetraedron</i>	640	960	240	560	1360	640	0	0	0	0	80	160	
<i>Treubania</i>	0	0	0	0	0	0	0	80	0	0	0	0	
<b>CHRYSOPHYTA</b>													
<i>Asterionella</i>	0	0	560	1280	560	80	0	0	0	0	0	0	
<i>Chrysochromulina</i>	10720	13600	18640	10720	1280	880	0	0	0	0	0	80	
<i>Chrysococcus</i>	0	0	80	0	0	0	0	80	160	160	0	0	
<i>Cyclotella</i>	0	0	0	160	160	80	0	160	400	240	400	160	
<i>Diceras</i>	0	0	0	80	0	80	0	0	0	0	0	0	
<i>Dinobryon</i>	0	0	160	0	0	3360	0	0	0	0	0	0	
<i>Kephryion</i>	0	80	0	160	80	0	0	0	0	0	0	0	
<i>Mallomonas</i>	0	0	0	0	80	0	0	160	0	0	0	160	
<i>Melosira</i>	1600	640	480	2000	3600	320	0	0	0	320	0	0	
<i>Nitzschia</i>	320	240	560	240	0	80	0	80	160	0	0	80	
<i>Rhizosolenia</i>	400	1200	2400	640	0	240	0	0	0	0	0	80	
<i>Synedra</i>	0	0	0	80	0	0	0	0	0	0	0	0	
<b>EUGLENOPHYTA</b>													
<i>Euglena</i>	0	0	0	0	80	0	0	0	0	0	0	0	
<i>Trachelomonas</i>	0	0	0	0	0	80	160	400	80	400	0	0	
<b>CRYPTOPHYTA</b>													
<i>Chroomonas</i>	80	0	80	0	0	240	0	400	400	160	1040	1920	
<i>Cryptomonas</i>	0	240	240	160	160	80	80	0	240	160	80	160	
<i>Rhodomonas</i>	0	480	240	80	0	0	0	80	0	0	0	0	
<b>PYRRHOPHYTA</b>													
<i>Glenodinium</i>	0	0	0	0	0	0	80	0	0	0	0	0	
<b>CYANOPROKARYOTA</b>													
<i>Anabaena</i>	0	0	0	0	0	0	0	15440	2560	0	0	0	
<i>Merismopedia</i>	0	0	0	0	5120	0	0	0	0	0	0	0	
<b>SUMMARY STATISTICS</b>													
<b>DENSITY (Cells / ml):</b>													
CHLOROPHYTA	1920	2400	3920	6560	7280	2960	800	3440	3680	4560	2080	800	
CHRYSPHYTA	13040	15760	22880	15360	5680	5200	0	400	640	720	560	560	
EUGLENOPHYTA	0	0	0	80	80	80	160	400	80	400	0	0	
CRYPTOPHYTA	80	720	560	240	160	320	80	400	720	320	1120	2080	
PYRRHOPHYTA	0	0	0	0	0	0	80	0	0	0	0	0	
CYANOPROKARYOTA	0	0	0	0	5120	0	0	15440	2560	0	0	0	
UNKNOWN ALGAE	0	0	0	0	0	0	0	0	0	0	0	0	
TOTAL	15040	18880	27360	22160	18320	8560	1120	20080	7680	6000	3760	3440	
<b>RELATIVE ABUNDANCE:</b>													
CHLOROPHYTA	12.8%	12.7%	14.3%	29.6%	39.7%	34.6%	71.4%	17.1%	47.9%	76.0%	55.3%	23.3%	
CHRYSPHYTA	86.7%	83.5%	83.6%	69.3%	31.0%	60.7%	0.0%	2.0%	8.3%	12.0%	14.9%	16.3%	
EUGLENOPHYTA	0.0%	0.0%	0.0%	0.0%	0.4%	0.9%	14.3%	2.0%	1.0%	6.7%	0.0%	0.0%	
CRYPTOPHYTA	0.5%	3.8%	2.0%	1.1%	0.9%	3.7%	7.1%	2.0%	9.4%	5.3%	29.8%	60.5%	
PYRRHOPHYTA	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	7.1%	0.0%	0.0%	0.0%	0.0%	0.0%	
CYANOPROKARYOTA	0.0%	0.0%	0.0%	0.0%	27.9%	0.0%	0.0%	76.9%	33.3%	0.0%	0.0%	0.0%	
UNKNOWN ALGAE	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	
TOTAL	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	
<b>TAXONOMIC RICHNESS:</b>													
CHLOROPHYTA	4	5	6	6	6	4	1	9	6	4	3	3	
CHRYSPHYTA	4	5	7	9	5	9	0	3	3	3	2	5	
EUGLENOPHYTA	0	0	0	0	1	1	1	1	1	1	0	0	
CRYPTOPHYTA	1	2	3	2	1	2	1	1	3	2	2	2	
PYRRHOPHYTA	0	0	0	0	0	0	1	0	0	0	0	0	
CYANOPROKARYOTA	0	0	0	0	1	0	0	1	1	0	0	0	
UNKNOWN ALGAE	0	0	0	0	0	0	0	0	0	0	0	0	
TOTAL	9	12	16	17	14	16	4	15	14	10	7	10	
<b>CHLOROPHYLL a (ug / L):</b>													
TOTAL	7.9	9.1	9	5.3	6.1	0.9	0.3	4.8	5	12.4	4.4	3.1	



CHESTERFIELD COUNTY UTILITIES  
ADDISON-EVANS WATER PRODUCTION AND LABORATORY FACILITY

2005 PHYTOPLANKTON ASSESSMENT OF SWIFT CREEK RESERVOIR SITE 8



ADDISON - EVANS WATER PRODUCTION AND LABORATORY FACILITY  
SWIFT CREEK RESERVOIR

PHYTOPLANKTON ASSESSMENT OF ALGAL BLOOM

---

Date collected: 10/18/05

Collectors: CLT / JTR

Date analyzed: 10/19/05

Analyst: CFH

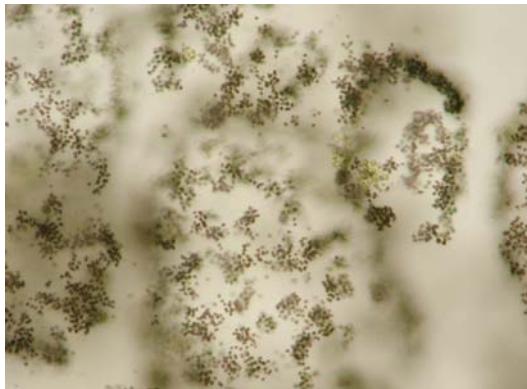
**Notable comments:** Live sample count

Counts could not be obtained. Sample difficult to count.

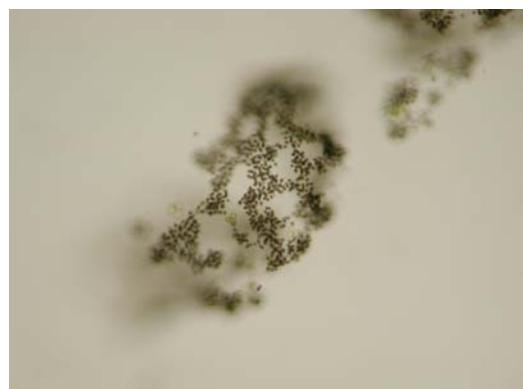
**Swift Creek Reservoir location:** Observed at site 5 and 8, Sunday Park and Intake Bay during supplemental reservoir survey.

---

**Microcystis (Phylum Cyanoprokaryota)**



200X Mag



200X Mag

**Comments:**

*Microcystis* floating on surface. Images from sample collected at site 8.

**Critical limit for *Microcystis*:** 3,500,000 cells/100 mL

**Odor at large quantities (*Microcystis*):** Rotten, septic, medicinal

Reference: AWWA. Identification and Treatment of Tastes and Odors in Drinking Water. 1987. Pages 65-76.

---

G\Lab\Algae\2005 AlgaeData\MicrocystisBloomOct05.xls

ADDISON - EVANS WATER PRODUCTION AND LABORATORY FACILITY  
SWIFT CREEK RESERVOIR

PHYTOPLANKTON ASSESSMENT OF ALGAL BLOOM

---

Date collected: 08/03/05  
Collector: GED  
Date analyzed: 08/04/05  
Time analyzed: 1000  
Analyst: CFH

**Notable comments:** Live sample analysis and identificaion, but no counts obtained. Trichomes showed oscillating movement , no sheath and were not arranged in parallel bundles, but instead solitary or intermingled.

Swift Creek Reservoir location: Localized bloom - off old dock site in intake bay

---

**Oscillatoria (Phylum Cyanoprokaryota)**



100X Mag



400X Mag

Identified as *Oscillatoria geminata*

Critical limit: 300,000 colonies/100 mL

Odor at large quantities: musty/spicy

Reference: AWWA. Identification and Treatment of Tastes and Odors in Drinking Water. 1987. Pages 65-67

Images compared to website: <http://www.plantbio.com/Bio2/Fphytopl/fpp2023.htm>

---